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CONTROL STATION DESIGN CONCEPTS FOR CENTER CONSOLE, DECK AND PO--ETC(U)

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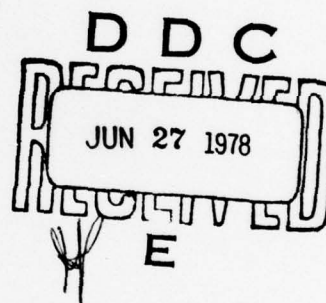
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REPORT NO. CG-D-68-77

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CONTROL STATION DESIGN CONCEPTS
FOR CENTER CONSOLE
DECK AND PONTOON BOATS



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PREPARED FOR
U.S. DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD
OFFICE OF BOATING SAFETY
WASHINGTON, D.C. 20590

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Technical Report Documentation Page

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16. Abstract: These concepts have been developed to assist boat builders and designers in planning the control station of the titled boat types. Utilization of these concepts should provide adequate visibility, space and control locations for 90% of the user population while minimizing safety hazards within the control station envelope. These concepts cover the design of control stations that do not approximate the characteristics of the automobile control station, and should be used only for control stations: a. Designed for standup as well as seated operation, and b. With a seat to floor distance exceeding 1 1/2 feet, and c. Having a cockpit deck less than 1 1/2 feet above the waterline. If your control station is not going to designed to comply with a and b, and c, above, do not use this document. Instead, obtain & use: a. Control Station Design Concepts for Bassboats, Bowriders, Runabouts, Skiboats and other Control Station Designed for Sitdown Operation Only, or b. Control Station Design Concepts for Cabin Cruisers and Flying Bridges.		
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FOREWORD

These Control Station Design Concepts were developed by the U. S. Coast Guard to assist boatbuilders and designers in planning the control stations of various types of boats. These concepts are non regulatory. Instead they are suggestions based on human factors engineering techniques which if followed will provide adequate visibility, space and control orientations for 90% of the user population. At the same time the designer will be minimizing safety hazards within the control station. Flexibility should be used in applying these concepts to individual designs.

There are three reports in this project. Each covers a different type of boat. Users of these concepts are reminded to make sure that their boats are in compliance with all current regulations. Any questions should be directed to your Coast Guard District Boating Standards Office.

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**CONTROL STATION DESIGN CONCEPTS
FOR
CENTER CONSOLE, DECK,
& PONTOON BOATS,
AND
OTHER CONTROL STATIONS DESIGNED FOR
STANDUP/SITDOWN OPERATION **EXCEPT** LOWER
CONTROL STATIONS ON CABIN CRUISERS**

OBJECTIVE: These concepts have been developed to assist boat builders and designers in planning the control stations of the titled boat types. Utilization of these concepts should provide adequate visibility, space, and control locations for 90% of the user population while minimizing safety hazards within the control station envelope.

SCOPE: These concepts cover the design of control stations that **Do Not** approximate the characteristics of the automobile control station, and should be used only for control stations:

- A. Designed for standup as well as seated operation, and
- B. With a seat to floor distance exceeding 1½ feet, and
- C. Having a cockpit deck **less** than 1½ feet above the waterline.

If your control station is not going to be designed to comply with A and B, and C, above, **Do Not** use this document. Instead, obtain & use:

- Control Station Design Concepts for Bassboats, Bowriders, Runabouts, Skiboats and Other Control Stations Designed for Sitdown Operation **Only**, or
- Control Station Design Concepts for Cabin Cruisers and Flying Bridges

NOTE: These concepts were developed primarily for boat builders; however, dealer and/or owner installed equipment may conform to the criteria recommended herein.

There are two parts to these concepts:

Part 1 Is for boat builders who do not use detailed drawings. It consists of a step-by-step procedure to develop a well designed control station and is structured as follows:

Section 1 Will lead you through a procedure to determine if you have adequate visibility while standing at the control station.

Section 2 Locates the steering wheel in the proper position.

Section 3 Locates the shift and throttle controls.

Section 4 Locates other controls and instruments.

Section 5 Positions the seat and suggests alternatives to the traditional seat concept.

Section 6 Locates windshields.

Section 7 Locates tops and discusses side curtains and dodgers.

Section 8 Discusses the glare problem.

Part 2 Profile drawings to $\frac{3}{4}" = 1'0"$, $1" = 1'0"$, and $1\frac{1}{2}" = 1'0"$ designed to be slipped under working drawings for tracing purposes.

If you do use scale drawings you should consult the text for details of:

Philosophy of Wheel Type and Placement	Section 2
Details of Shift/Throttle Control Type & Placement	Section 3
Instrument and Switch Placement	Section 4
Philosophy of Seat Selection	Section 5
Windshield Details	Section 6
Side Curtains & Dodger Design	Section 7
Glare Producing Surfaces	Section 8

PART 1

CONSTRUCTION OF A CONTROL STATION FOR THOSE WHO DO NOT USE DETAILED DRAWINGS

ASSUMPTIONS: You have a hull sitting on a cradle or somehow blocked up. Any cabins or structures that would limit the operator's visibility of the bow have been installed. The cockpit sole or deck is in place and you have planned the location of the control console. You are ready to plan the dimensional characteristics of the control station including the panel, seat, and controls.

NOTE: The old axiom "Pictures Say a Thousand Words" is true in using this booklet. An **accurate** scale drawing of your boat in scales corresponding to those specified earlier will greatly simplify the use of this document. By slipping the scale control station drawing under your tracing you should be able to:

- Determine if you have adequate forward visibility.
- Determine where to place the wheel & shift/throttle mechanism.
- Place the seat correctly.
- Place the windshield & grabrails correctly.
- Provide enough headroom under the top.

SET UP HULL: You should have a pretty good idea of how your boat will float when it is loaded with engine, fuel, and a normal load of people and gear. We are talking about the waterline while the boat is **at rest**. Chock up the hull so that this waterline is level. In most cases the boat will now be sitting in a slight bow-up attitude.

If you aren't sure how your boat will sit in the water, look at similar boats in the water or in advertisements. Set yours up at the same angle.

1.0 STANDING VISIBILITY

The first step will be to determine if the operator, standing at the proposed helm station, will have adequate visibility over the bow. If your boat doesn't have anything forward of the control station area that could obscure the bow from view, follow the procedure described below.

The first thing you should do is rig a horizontal line aft from the bow. Measurements will be taken from this line to determine if the visibility from your boat meets certain minimums. If you cannot see the bow proceed to Section 1.1.

Check Sketch Over Table I

Use a long board and carpenter's level or a string and line level (shown). Measure the distance from the bow back to a point directly over the spot on the floor where the operator will be standing. That will be **Dimension A**.

Next measure the distance from the string down to the spot on the floor where the operator will stand while driving. That is **Dimension B** for use in Table I.

Find the number in the left column (A) of Table I that is closest to **but more than** your Dimension A. (The next higher number). Your Dimension B should be less than the number in the same row under Column B. For instance, if your Dimension A is 98 inches, you would enter Table I at 100 inches in Column A and move right to 46 inches in Column B. Your Dimension B would have to be less than 46 inches.

A STRING STRETCHED
VERY TIGHTLY

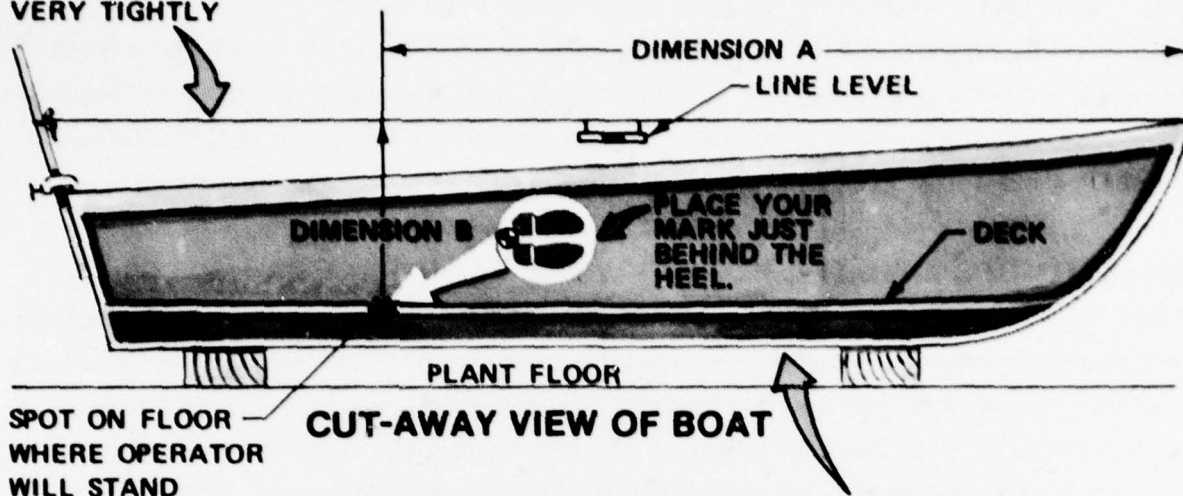


TABLE 1*

COLUMN A MINIMUM DISTANCE FROM SRP TO BULKHEAD	COLUMN B SEAT HEIGHT DISTANCE FROM FLOOR TO SRP
INCHES	INCHES BELOW BOW
50	53
60	51½
70	50
80	48½
90	47½
100	46
110	44½
120	43
130	41½
140	40½
150	39
160	37½
170	36
180	34½
190	33½
200	32
210	30½
220	29
230	27½
240	26½
250	25
	8° Visibility Angle

NOTE: For simplicity the sketches show the keel as being level. If you've leveled the boat to an anticipated static load waterline the keel may not be level.

Dimension B measured on your boat should be **less** than the value shown in the right column. If your Dimension B is greater than the value shown in the right hand column you can:

1. Move the Control Station forward.
2. Raise the Floor.
3. Lower the Bow. Caution, this alternative could affect the seaworthiness of the boat.

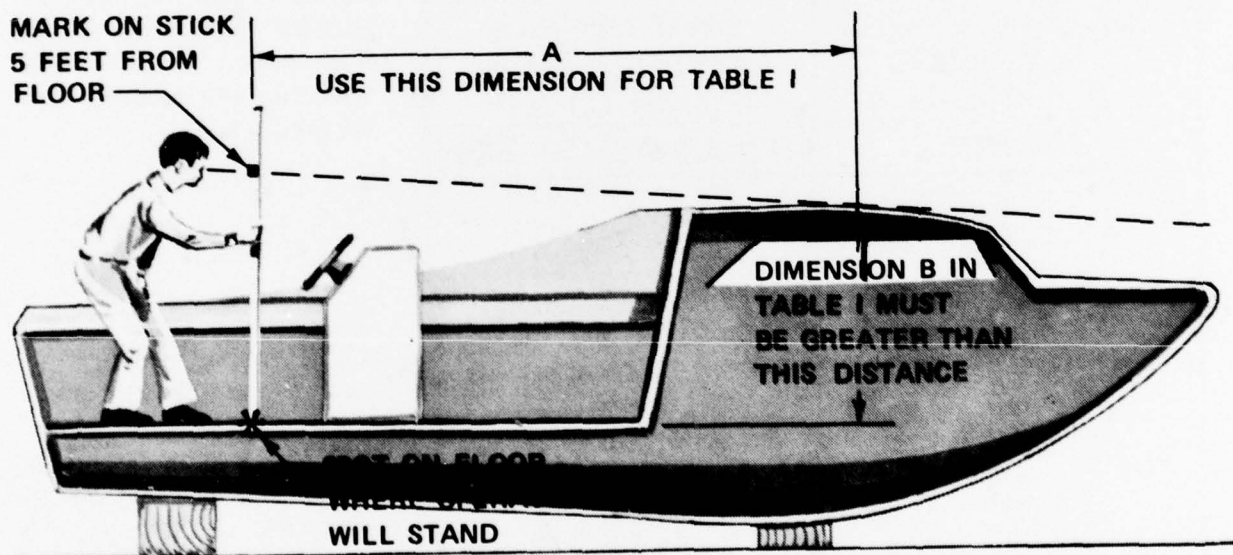
*Table 1 is based on a 60" standing eye height. (5th percentile male or 50th percentile female) and an 8° angle between the visibility line and the LWL.

1.1 DO THIS IF YOU COULD NOT SEE THE BOW

You won't be able to use the bow as a reference point if you can't see the bow from the operator's standing position or if you won't be able to see it when the boat is completed because some portion of the boat structure is obscuring it. Instead you should use the most forward point on that structure that you can see as a reference point.

HOW TO DETERMINE THE MOST FORWARD POINT THAT CAN BE SEEN.

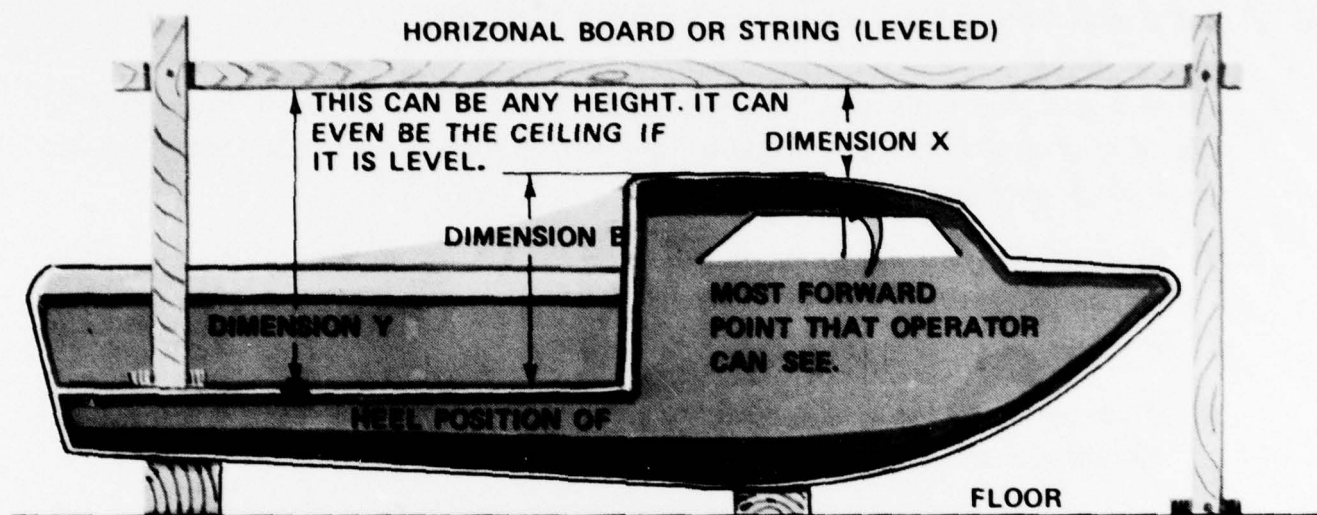
Mark a stick 5 feet from the end and stand it vertically on the spot where the operator will stand. Stand behind the stick and sight forward so that your line of sight crosses the mark on the stick. If you can see the bow over the structures that you were concerned about forget this whole subsection. If you can't, mark the most forward point on the highest structure that you can see. Use this point instead of the bow to determine if your floor (cockpit sole) is high enough. See sketch below.



CUT-AWAY VIEW OF BOAT

Measure distance **A** above. Go to Table I. Find the number in the left column (**A**) that is closest to **but more than** your Dimension **A** (the next higher number). Your Dimension **B** must be **less** than the number in the same row under Column **B**. Check the example under 1.0.

How can you measure Distance **B** on your boat? Here's a suggestion. Rig a contraption similar to that shown below or use a string instead of the horizontal board. Measure X and Y. Subtract X from Y. The number that you get should be smaller than Dimension **B** from Table I (opposite your Dimension A).



CUT-AWAY VIEW OF BOAT

	DIMENSION Y	INCHES
Subtract	DIMENSION X	INCHES
	DIMENSION B	INCHES

SUMMARY

1. Determine and mark operator's standing position.
2. Level waterline and measure from the most forward point that you can see back to a point directly over the operators' heel position.
3. Measure from the floor up to a point level with the most forward point that you can see. Compare this figure with the appropriate figure in Table I. If your dimension is less, you're in good shape. Continue to Section 2. If yours is greater, follow suggestions beside Table I.

2.0 THE STEERING WHEEL

In this section we will attempt to locate the steering wheel so that it is convenient to use while standing, and can also be used when seated. You should decide whether you want a vertical wheel or an angled wheel and the approximate wheel diameter. The location of the steering shaft, and subsequently the position and angle of the control panel mounting surface, will depend on these decisions.

Control stations of this type have been designed with wheels from 9" through 30" in diameter installed at angles ranging from vertical through horizontal. What is best? Here are some recommendations:

1. The angled wheel is more comfortable for the seated operator than is the vertical wheel. This is true only if the seat/angled wheel relationship allows the operator to slide his legs under the wheel.
2. An angled wheel is usually easier to spin quickly because of its' orientation to the standing or sitting operator's arms.
3. The protruding spokes of an external spoked wheel catch on clothing. The use of an external rimmed wheel will avoid the problem.

The important variables that must be considered when planning the position of the steering wheel are:

1. Wheel Height
2. Wheel Angle
3. Wheel Diameter
4. Horizontal distance from operator's heel position to aft edge of wheel.
5. Hand clearance around wheel.

Wheel height, diameter, and distance from heel position to aft edge of wheel depend on wheel angle. Select the wheel angle that you want to use and locate your control panel so that the wheel is positioned within the limits shown in Table II, below.

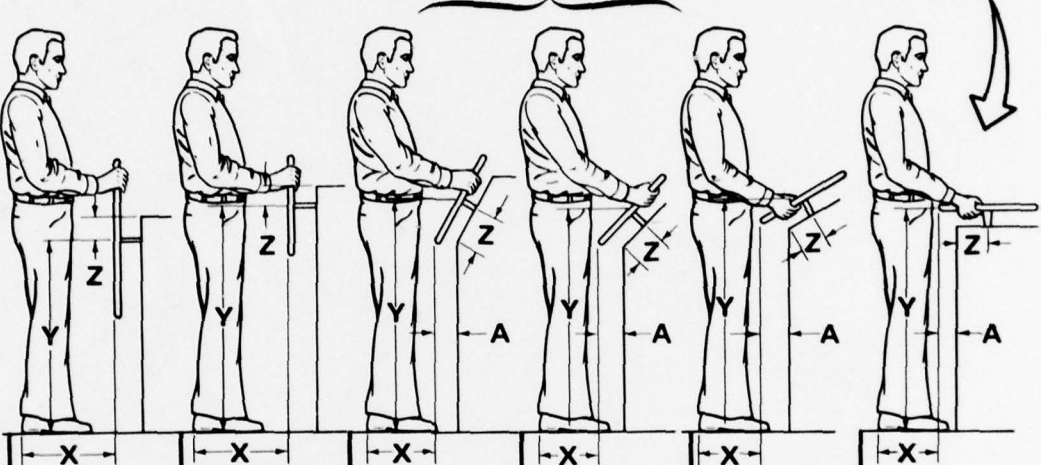
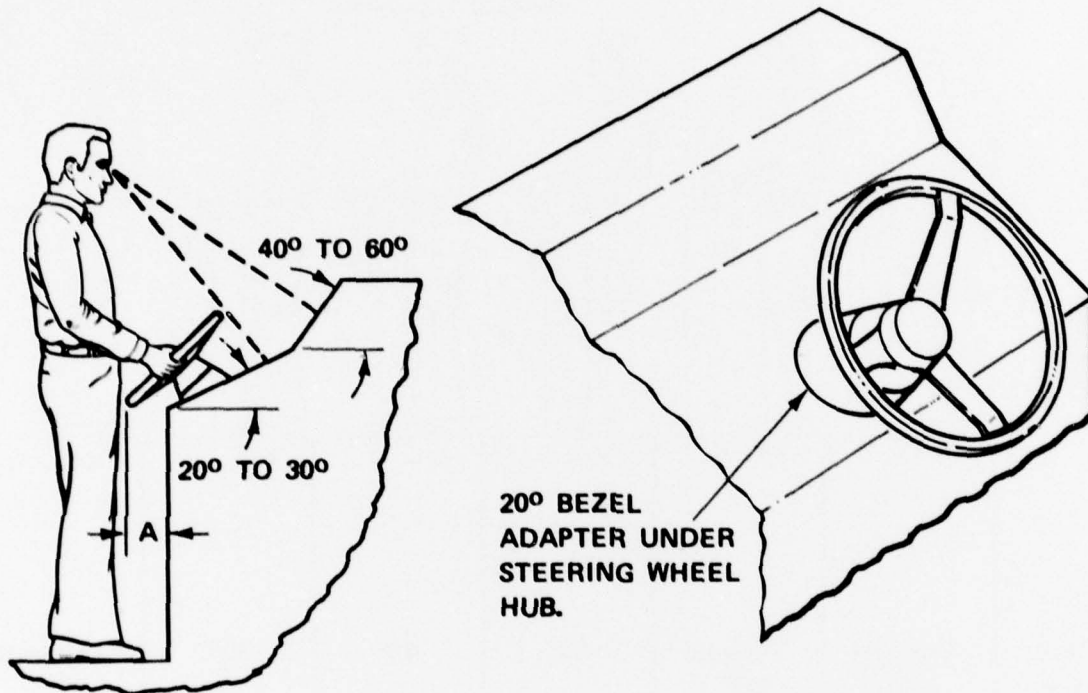
	MOST BOAT OPERATORS PREFER WHEELS WITHIN THIS RANGE OF ANGLES.					NOT RECOMMENDED
						
Wheel Angle	Vertical (90°)	Vertical (90°)	60°	45°	30°	Horizontal (0°)
Dimension Y	28" to 32"	33" to 38"	34" to 39"	35" to 39"	36" to 39"	37" to 40"
Wheel Diameter	24" to 36"	18" to 24"	13" to 18"	13" to 15"	13" to 15"	13" to 15"
Dimension X	12" Min.	12" Min.	9" Min.	9" Min.	9" Min.	9" Min.
Dimension Z	Dimension Z should be as small as possible allowing the steering mechanism sufficient room under the panel.					
Dimension A	Dimension A should be as large as possible to provide knee room for the seated operator and foot room for the standing operator.					

TABLE II STEERING WHEEL PLACEMENT

2.1 THE CONTROL PANEL

The panel should be located on an angle that is approximately perpendicular to the operator's line of sight. Notice that the panel under the 30° wheel in Table II comes very close to meeting that criterion. Another configuration that meets that criterion and also maximizes Dimension A is shown below. The example of switch and instrument location criteria in Section 4.0 builds on this configuration.



Placing switches and instruments on surfaces which approach horizontal invites water entry leading to service problems. The 40° to 60 ° portion of the panel is still fairly perpendicular to the standing operator's line of sight and becomes an excellent place to locate instruments and switches.

SUMMARY

1. Select the angle and size wheel you want to use.
2. Determine wheel position from Table II.
3. Construct panel to support wheel. Make Dimension A as large as possible.

3.0 SHIFT/THROTTLE MECHANISMS

The location of the shift/throttle (S/T) mechanism will depend on:

- The type and size of the steering wheel.
 - Angled
 - Vertical
- The type of S/T mechanism.
 - Deck Mounted
 - Side Mounted

Section 3.1 offers suggestions for placement of deck mounted S/T mechanisms for both wheel configurations. Section 3.2 offers suggestions for placement of side mounted S/T mechanisms.

Pitfalls to avoid are:

- Excessive reach distances; especially for the seated operator.
- Shift handles — Too Close to wheel,
 - Behind the wheel,
 - So high that they are in the operator's field of view,
 - So close to the deck that knuckles are rapped when the handles reach their extreme positions.

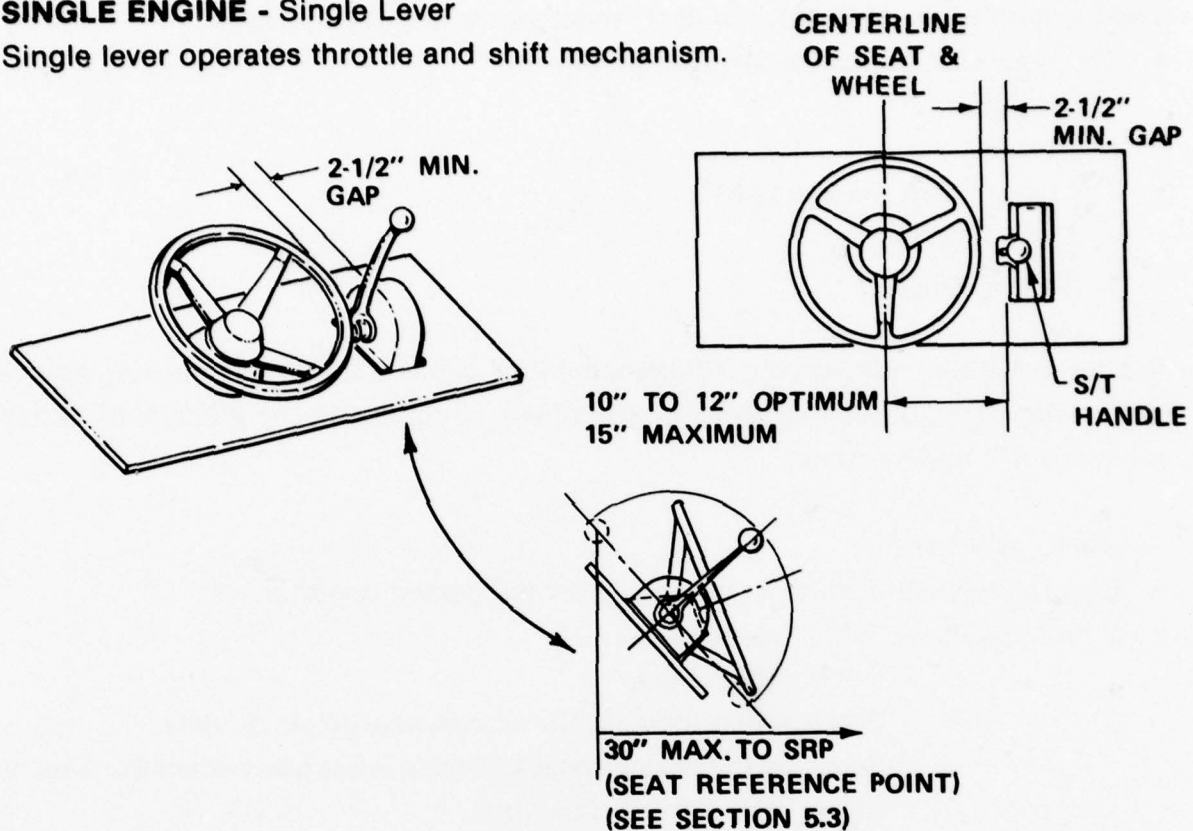
Recommendations:

- Position the S/T mechanism beside the angled wheel, not in front of it.
- When a vertical wheel is used, mount the S/T mechanism as far aft and as low as possible. Mounting it on an angle helps to reduce reach distance.

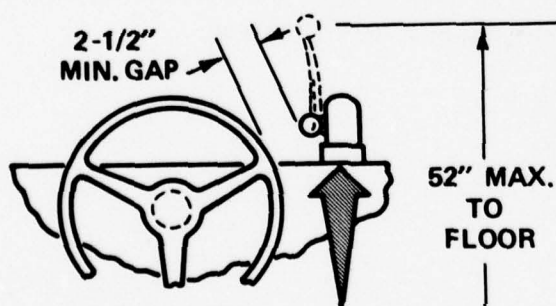
3.1 DECK MOUNTED S/T MECHANISMS

SINGLE ENGINE - Single Lever

Single lever operates throttle and shift mechanism.

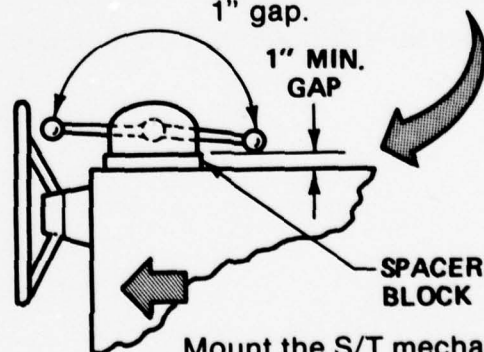


VERTICAL WHEEL



Deck height should be as low as possible. It makes it a lot easier to move the S/T handle. (Especially for a short person.)

NOTE: S/T mechanism may have to be mounted on a block to maintain a 1" gap.

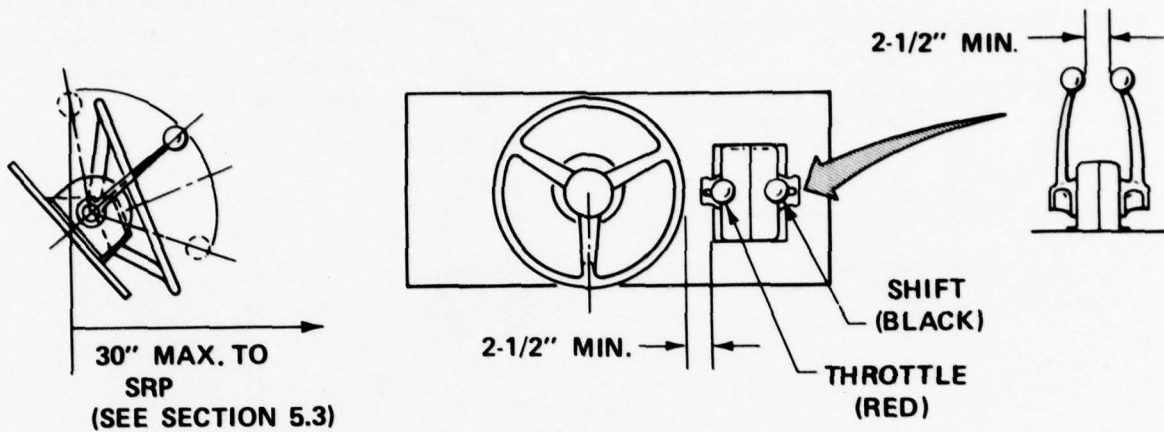


Mount the S/T mechanism as far aft as possible to minimize reach distance.

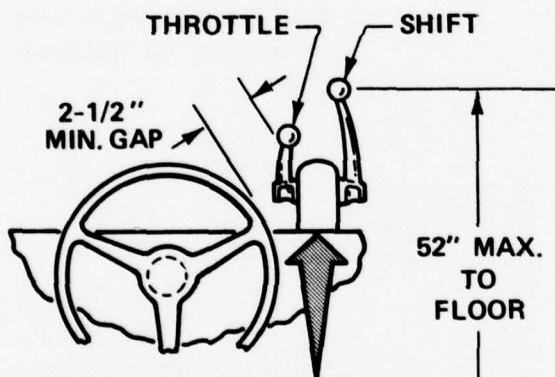
NOTE: See the recommendation for mounting the S/T mechanism on an angled surface: NEXT TWO PAGES.

SINGLE ENGINE - Two Levers

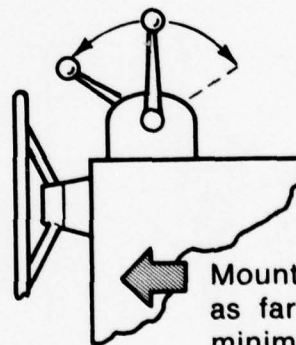
The handle closest to the wheel should be the throttle and should be color coded red. The knob on the shift lever should be black.



VERTICAL WHEEL

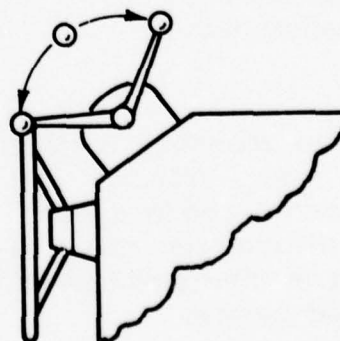


Deck height should be as low as possible. It makes shifting a lot easier for the short person.

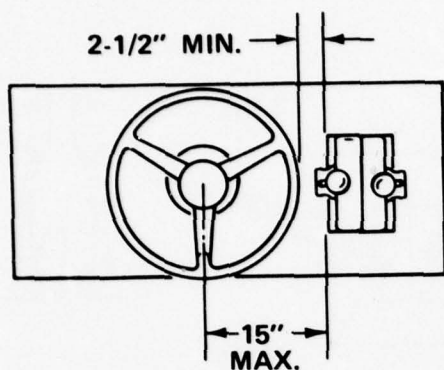


Mount the S/T mechanism as far aft as possible to minimize reach distances.

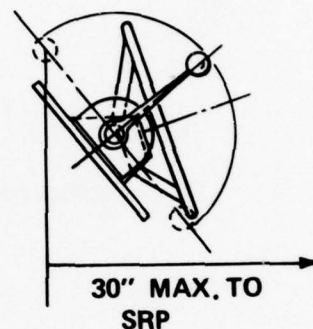
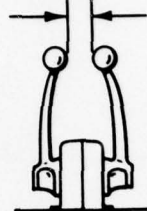
An angled mounting surface reduces reach distance. Instruments may be mounted on the remainder of the angled surface.



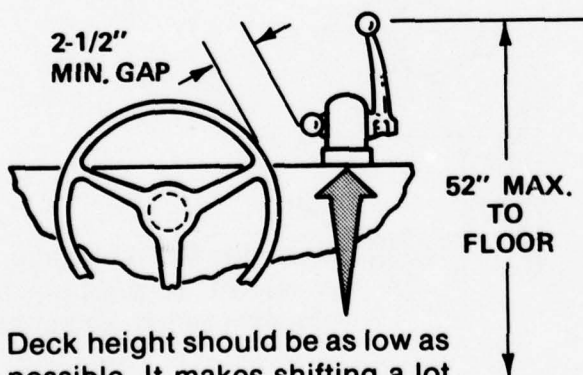
TWIN ENGINE - Single lever for each engine.



Knobs on handles should be close so they can be moved simultaneously with one hand.



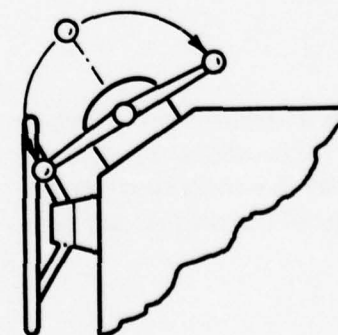
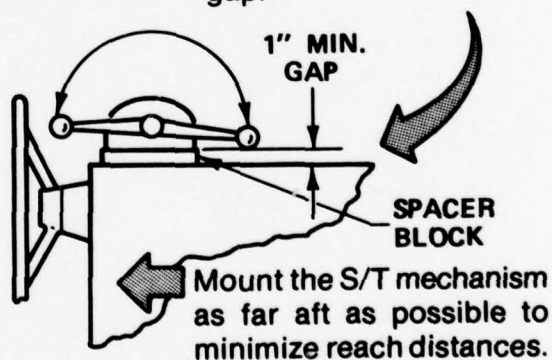
VERTICAL WHEEL



Deck height should be as low as possible. It makes shifting a lot easier for the short person.

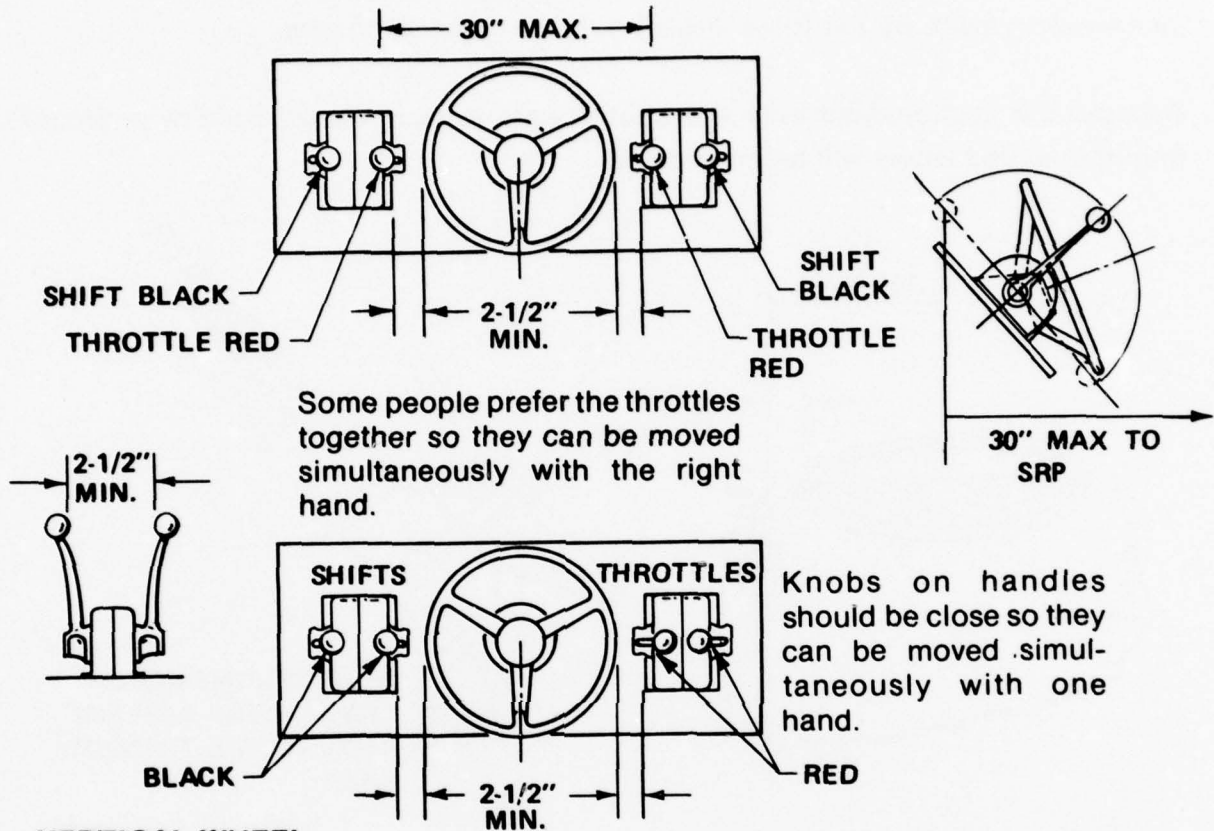
An angled mounting surface reduces reach distance and eliminates the need for a spacer block. Instruments may be mounted on the remainder of the angled surface.

NOTE: S/T mechanism may have to be mounted on a block to maintain 1" gap.



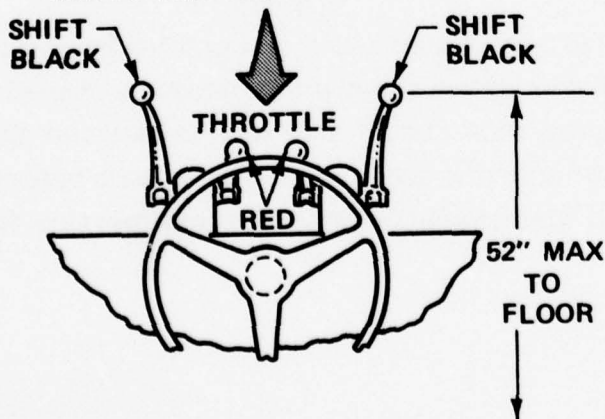
TWIN ENGINE - Two Levers

The handles closest to the wheel should be the throttle and should be color coded red. The knob on the shift lever should be black.

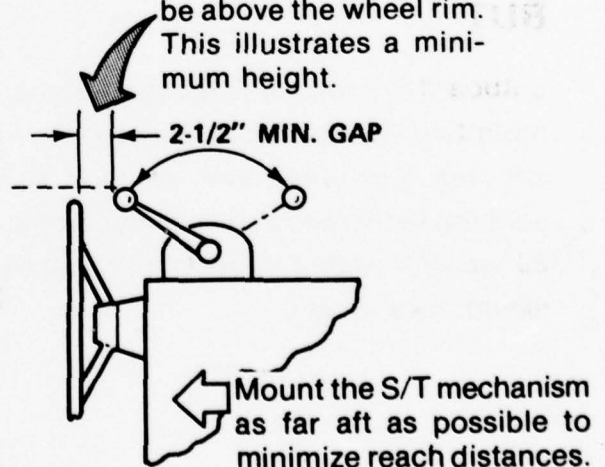


VERTICAL WHEEL

Knobs on throttle handles should be close so they can be moved with one hand.



In the idle position the throttle knobs should be above the wheel rim. This illustrates a minimum height.

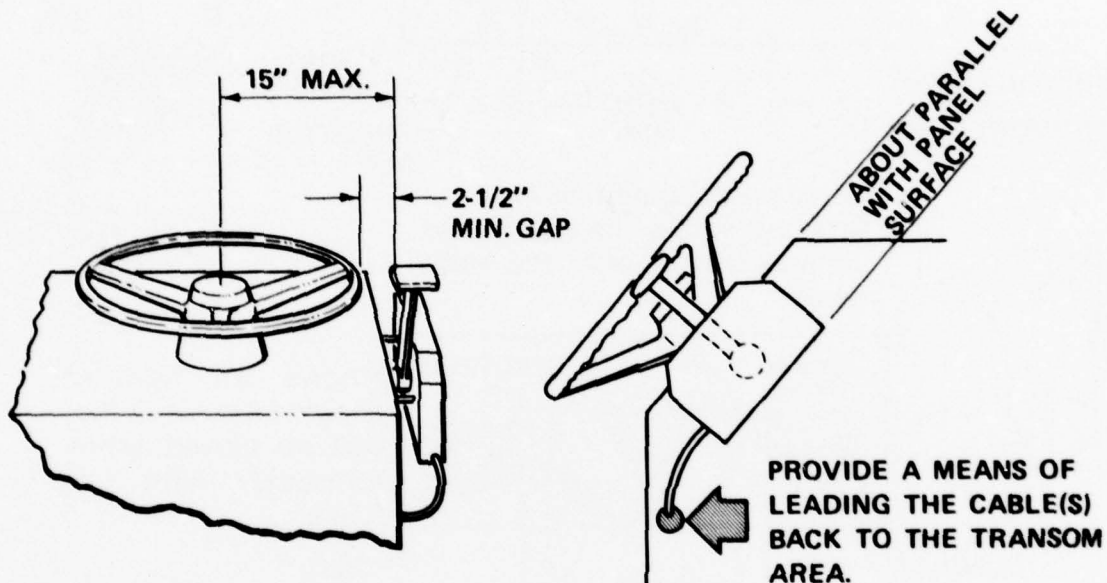


NOTE: Mounting the S/T mechanisms on an angled surface probably won't help in this configuration.

3.2 SIDE MOUNTED S/T MECHANISMS

Basically we are talking about outboard installations. You, the boat builder won't be installing the unit, but you should provide an obvious mounting surface for S/T mechanisms made by the three largest outboard manufacturers.

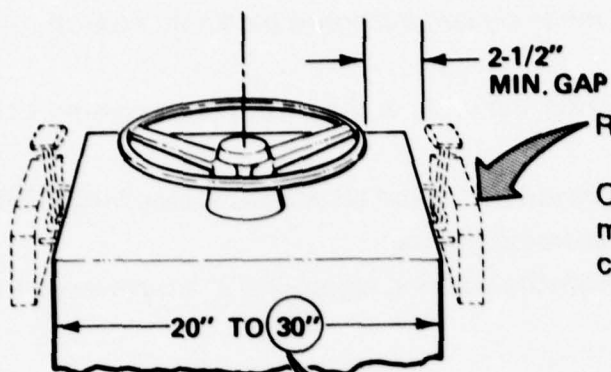
Because this section deals only with control stations on boats powered by outboards, only the angled wheel will be considered.



It is preferable to mount the S/T mechanism to the right of the wheel as shown,

BUT

outboard S/T mechanisms are designed to be mounted with their right side against the mounting surface. Some may be mounted as shown above through the use of adapter kits, but they won't look as good because their "back" side will be exposed. One solution to this problem is to mount the wheel in the center of a console that is between 20" and 30" wide. The dealer or buyer can mount the S/T mechanism on either side. See sketch, next page.

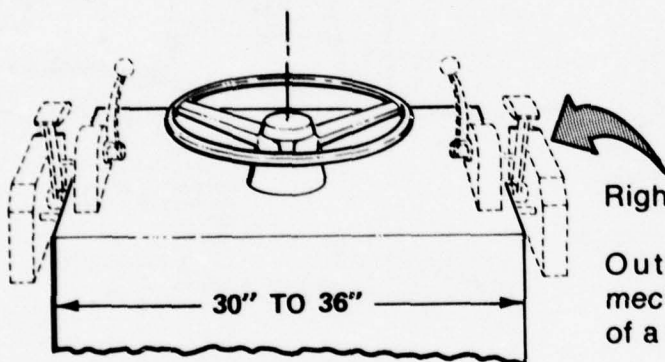


Right Side Mounting Preferred.

Outboard S/T mechanisms can be mounted on either side of a 20" to 30" wide console.

If the panel approaches 30" in width, it may be possible to mount a single lever deck-mounted S/T mechanism beside the wheel. Make sure there is 2½" clearance around the wheel.

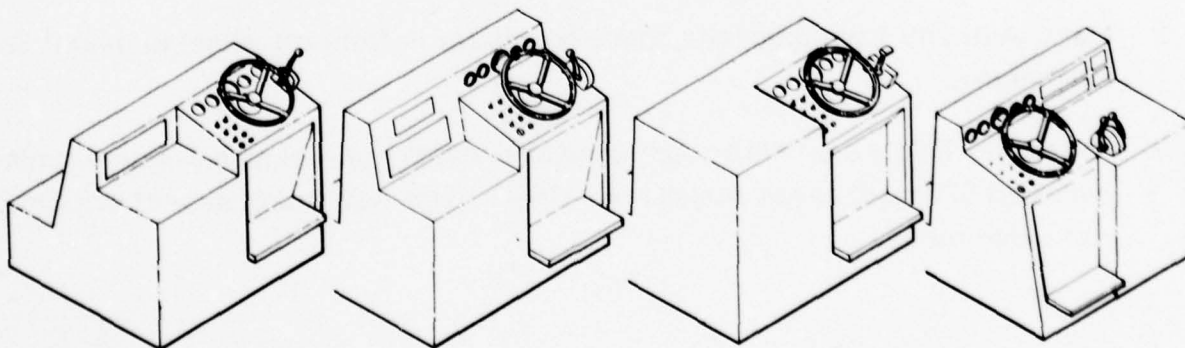
A 30" or 36" wide console with a wheel no larger than 15" in diameter will also accommodate a single deck-mounted S/T control beside the wheel. Alternate configurations are shown below:



Right Side Mounting Preferred

Outboard or deck mounted S/T mechanisms can be mounted on either side of a 30" to 36" wide console.

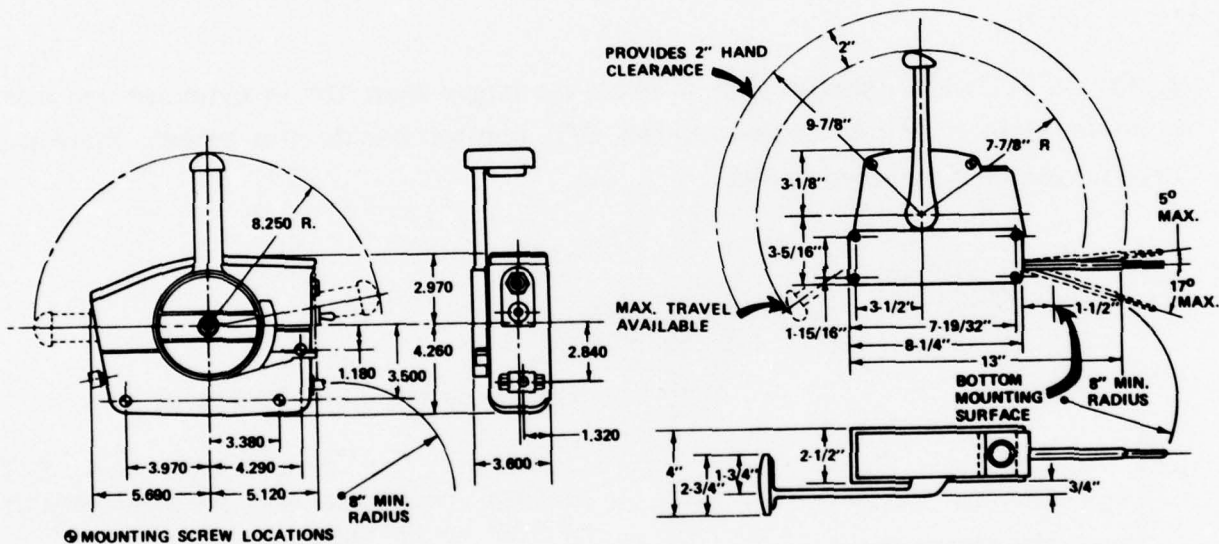
Some successful control station configurations.



Drawings below show S/T mechanisms made by two outboard motor manufacturers. Make sure:

- You have room under the console to bolt the units in the positions recommended above.
- The cables exiting from the units can be led down and aft without being forced into radii tighter than manufacturers' recommendations.
- The handle clearance is at least 2½" from the steering wheel and 2" from everything else.

While your console is still in the mockup stage you should try to mount one of the S/T mechanisms to confirm mounting access, cable run, and hand clearances.



SUMMARY

1. Check recommendations and pitfalls under 3.0.
2. Make sure you have adequate space beside (or in front of) wheel to mount S/T mechanism.
3. Install one. If your boat will be controlled by either a deck mounted or side mounted outboard S/T mechanism, install both. Check hand clearances, ease of mounting, and cable runs.

4.0 CONTROLS & DISPLAYS

The wheel and shift/throttle controls should receive top priority in terms of placement because they are used most often. The rest of the items that go onto the control panel should be considered as a system and include:

- Ignition/Start Switch.
- Bilge Blower Switch and the Accompanying Warning Statement.
- Bilge Pump Switch.
- Navigation Light Switch (Separate Switch for Panel Lights).
- Horn Switch (Button).
- Wiper and/or other accessory switches.
- Fuses for above circuits.
- Tachometer.
- Ammeter or Voltmeter.
- Temperature Gauge.
- Oil Pressure Gauge (Inboards).

Even though some of the above items may not be offered as standard equipment, you should leave space on the panel for dealer installations. In addition, where applicable you should provide space for:

- Compass.
- Depth Sounder or Depth Recorder.
- Speedometer.
- Communication Equipment.

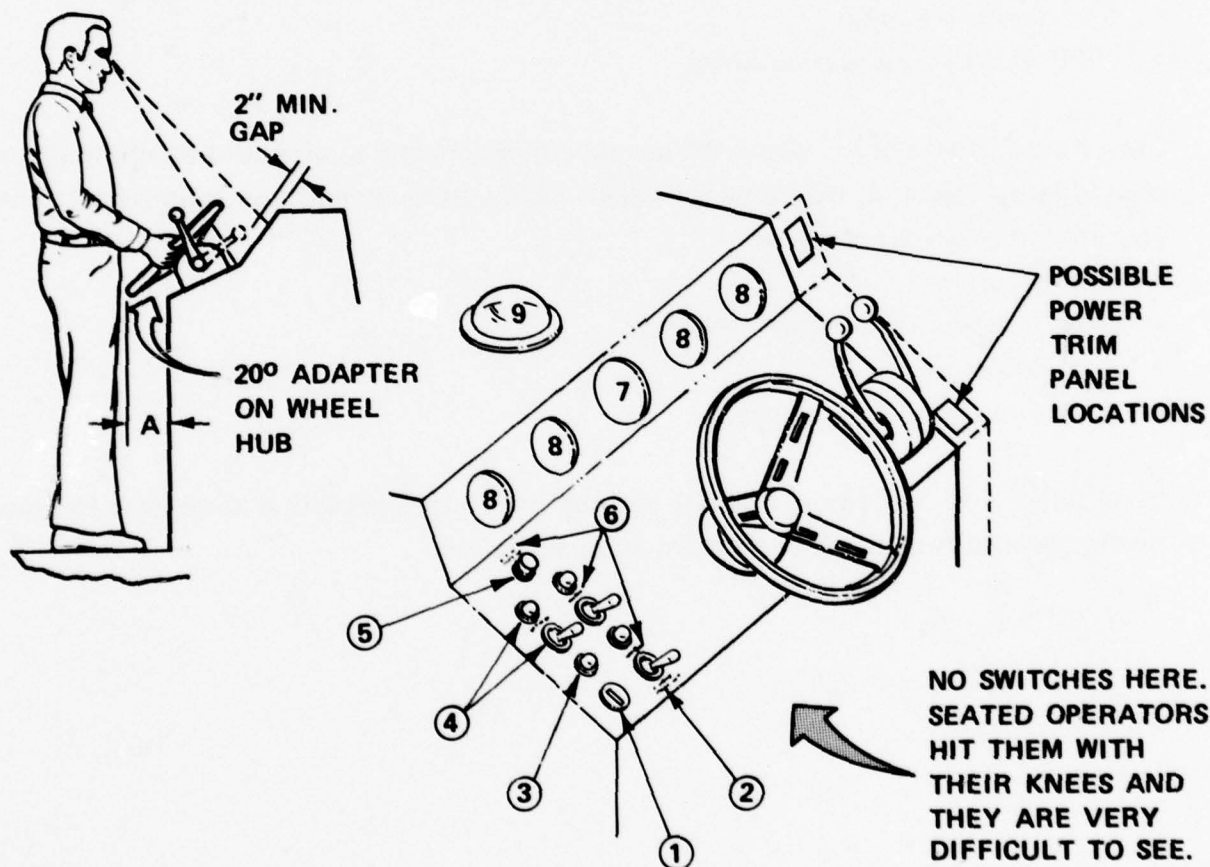
In addition, you should provide dry storage within the console and an area to place beverage bottles or cans, cigarettes, sunglasses, etc.

Where do you put controls & displays? The example below builds on one of the control panel configurations shown in Section 2.0. Instruments are on the surface with the greater angle to minimize water ingress problems. Switches are shown on the flatter surface. They could be put on the more vertical surface for the same reason, or you can cover them with a transparent cover for weather protection. If they are mounted as shown:

- Purchase sealed switches.
- Provide a cap for the ignition switch and the horn pushbutton.

Don't mount switches on the vertical surface on the rear of the console.

- They are very difficult to see.
- Seated operators hit them with their knees (damaging both the switch and the knee).



NOTE: Provide easy access to the back of the instruments. Watch out for water ingress through the access openings.

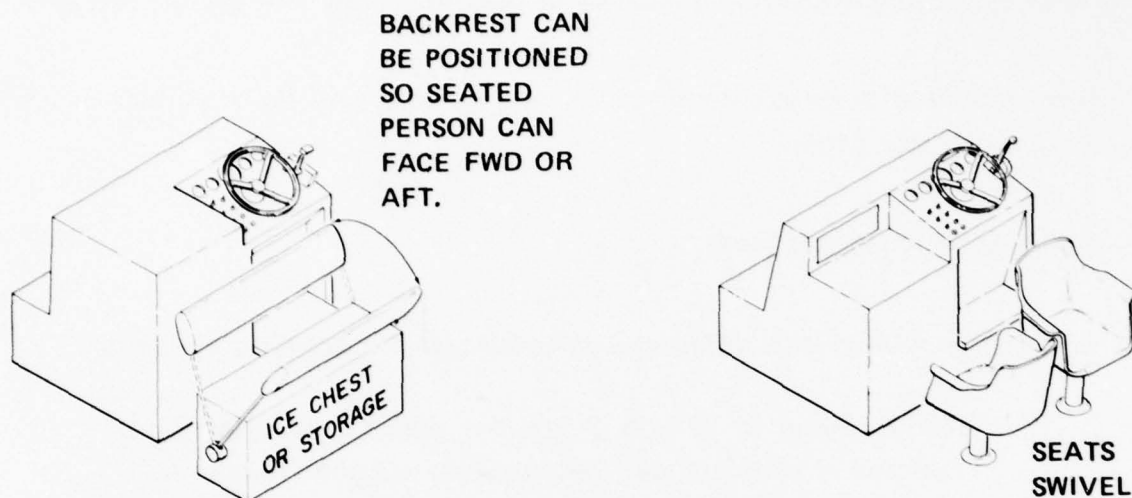
- ①. Mount the ignition switch on opposite side of wheel from throttle. This lets you operate starter and manipulate throttle simultaneously.
- ②. Blower switch & label should be positioned close to ignition switch. (The operator can't help seeing the switch & label as he inserts the key into the ignition switch.)
- ③. Panel mounted fuses are economical, easy to wire, and facilitate easy trouble-shooting by the owner.
- ④. Auxiliary switches and fuses.
- ⑤. Horn switch should look different and be placed in a prominent location.

NOTE: Items 6, 7, 8, & 9 are not necessarily safety oriented but are included because they are good human engineering principles.

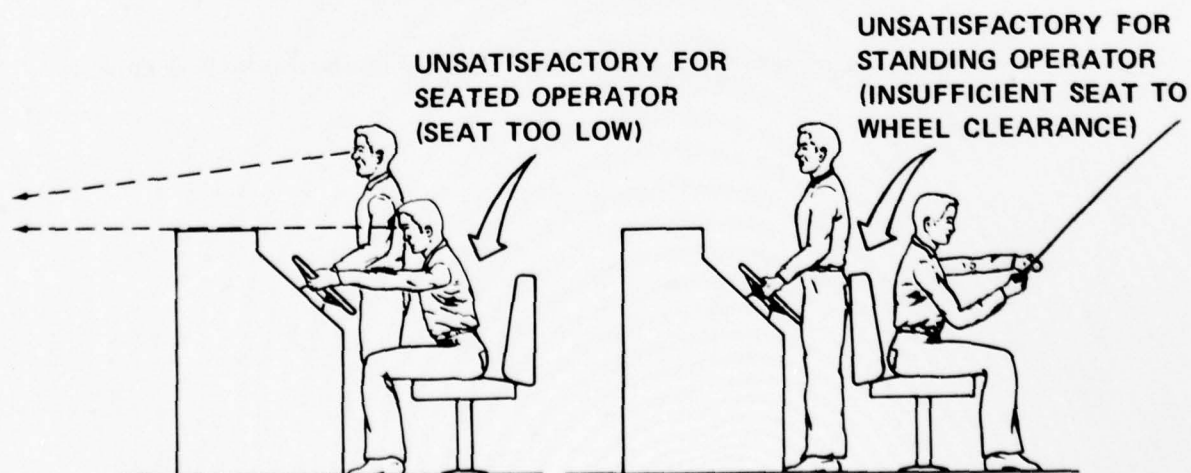
- ⑥. **Label all switches**, above the switch.
- ⑦. Tachometer is most frequently used display. Make sure the wheel rim doesn't hide it from view.
- ⑧. Try to place other gauges, especially temperature and pressure gauges, where the wheel rim won't obscure them from view.
- ⑨. Leave space for compass directly in front of centerline of wheel & seat.

5.0 THE SEAT

Center console boats have been primarily designed for fishing. Most have seats aft of the console that are designed to be used for driving or sitting while facing forward and also for fishing. Most look somewhat like those depicted in the sketches below.

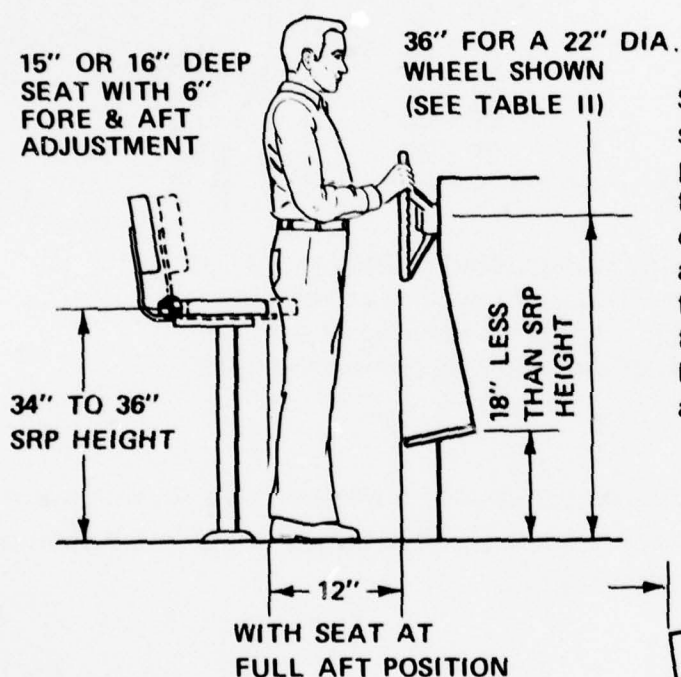


BUT: Seats currently installed in boats of this type are usually positioned about 18" above the deck to be comfortable while fishing. Since the control station is designed for the standing operator, the seat is too low for the operator to use. Many seats that swivel are mounted such that there is insufficient room for the operator to stand behind the wheel when the seat is facing aft. This tends to defeat the boat's purpose, i.e. one cannot maneuver the boat while another person fights a fish. See sketches. Section 5.4 offers alternative approaches to the problem.



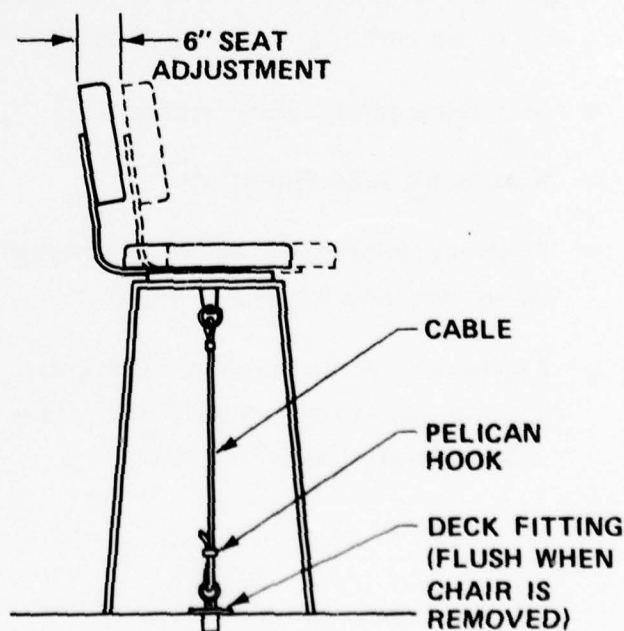
5.1 SEAT FOR BOATS WITH VERTICAL WHEEL

The 24" to 26" high seat was used with the angled wheel so that the seated operator's legs could slide under the wheel as he slid the adjustable seat forward. The vertical wheel is higher, the S/T controls are mounted higher, and the operator can't slide his legs under the wheel. Therefore, the seat should be mounted higher. A 36" SRP height has been used throughout the industry for a number of years and seems to be ideal. It places the wheel & controls at the right height. It also places the sitting and standing eyepoints at about the same height so you don't have to do another visibility check as described in Section 5.3.



Some manufacturers of pedestal chairs sell foot rests that mount to the pedestal. The problem with them is that they interfere with the standing operator's legroom when in position, and the operator must leave the wheel to loosen the clamp and swivel it out of the way. The built-in footrest shown at left is preferred because it is always available and never in the way.

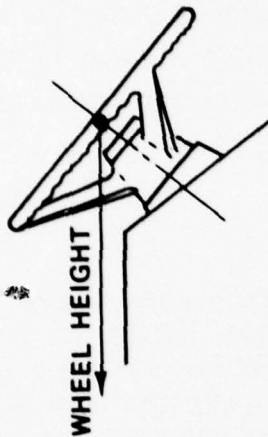
Pedestal seat shown. If you use a chair (4 legs and moveable) you should provide a method to secure it to the deck in the position shown. If you don't it will fall over in rough seas. One method is shown at right.



5.2 SEAT FOR BOATS WITH AN ANGLED WHEEL

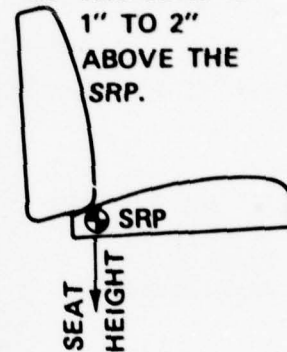
Important criteria are:

- **Seat Height**...depends on wheel height and can vary from 20" to 26" from deck to SRP (Seat Reference Point) as shown below:



WHEEL HT. (MEASURED AT CENTER OF RIM.)	SEAT HT. (MEASURED AT DEPRESSED SRP.)
INCHES	INCHES
39	24 - 26
38	23 - 26
37	22 - 25
36	21 - 24
35	20 - 23
34	20 - 22

NOTE: NORMALLY
THE FRONT EDGE
OF THE SEAT IS
1" TO 2"
ABOVE THE
SRP.



NOTE: Seated visibility is discussed in Section 5.3, but simply stated, the small operator will have to be able to see the horizon while the boat is running at a 4° trim angle. Your chances of meeting this criteria are better with a higher seat.

- **Fore/Aft Clearance**...provide a 9" horizontal space between aft edge of wheel and forward edge of seat (if the seat has fore & aft adjustment the measurement should be made with the seat in the full aft position).
- **Seat Dimensions**...See Section 5.5.
- **Fore & Aft Adjustment**...6".
- **Footrest**...located 18" to 20" below seat. Don't let it extend aft of the aft edge of the wheel. Provide toe space under it.
- **Alignment**...when looking from above, the centerline of the seat and the wheel should always coincide within 2". If the wheel is off center it should be towards the side opposite the S/T controls.

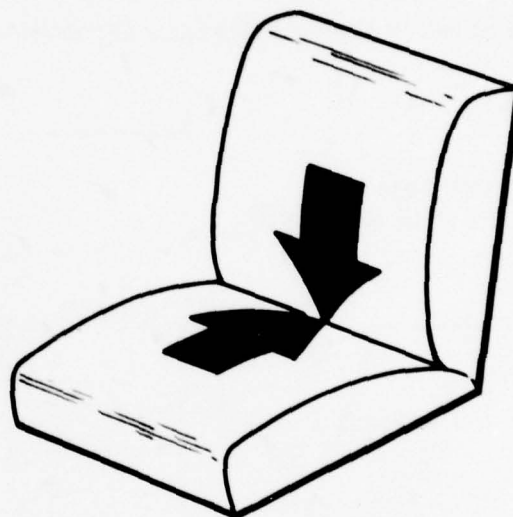
5.3 SEATED VISIBILITY — ANGLED WHEEL

Adequate visibility while standing is of extreme importance. We will assume that you have checked standing visibility and your boat exceeds the criteria. The seated operator's eye height is considerably lower than the standing operator's eye height. Because it is very easy for a seated operator to stand when the boat is trimmed abnormally high, the seated operator's visibility criteria **were** relaxed to include "normal" running angles, but not "maximum normal" running angles. Check the visibility as follows:

Determine the height of the Seat Reference Point (SRP). This is the intersection of the seat back and the depressed seat.

HOW TO FIND THE SRP

Have a person that weighs 150-175 lbs. sit in the seat. Measure the distance from the lowest point on his (her) bottom to the floor. That's the SRP height.



If you haven't purchased the seat yet subtract 1" from the specified seat height. Use that dimension as your SRP height.

Next add 27" to the SRP height. (This is the 5th percentile male seated eye height.) For example, if you have chosen a 25" high seat, add 24" (SRP height) and 27" (eye height) = 51".

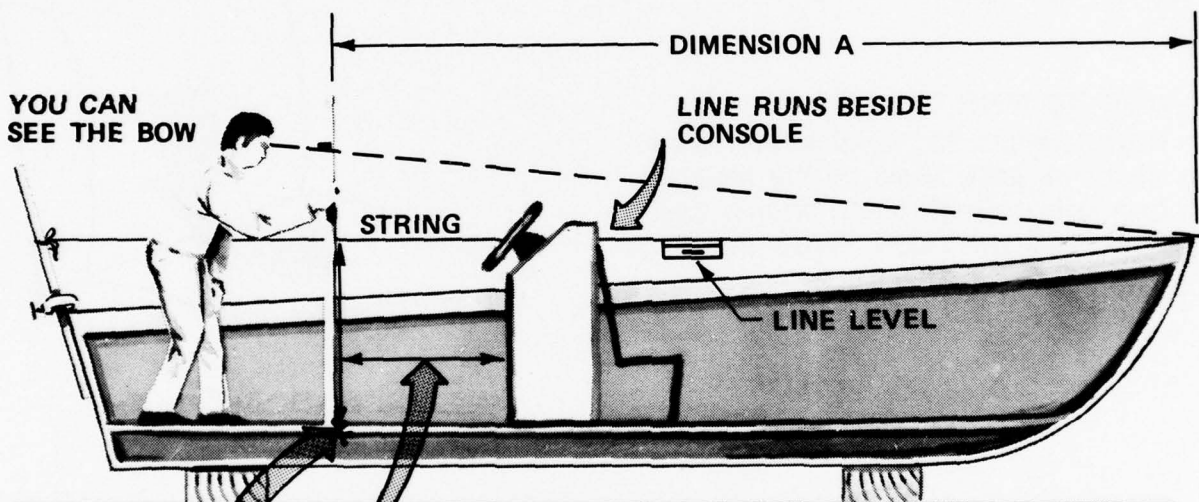
Mark a stick at a point 27" above the SRP. (51" is our example.) Mark a spot on the floor 25" aft of the aft point of an angled wheel or 25" aft of a vertical wheel. Stand the stick on that point and sight across the mark. If you can see the bow proceed as follows:

Details on next page.

DO THIS IF YOU COULD SEE THE BOW

Rig another horizontal string back from the bow. Measure the distance from the bow back to a point directly over the spot on the deck that is 25" aft of the wheel. That will be **Dimension A**. Next measure the vertical distance from that spot on the deck to the string above it. Subtract the SRP height from that distance. Your answer should correspond to **Dimension B** in Table III.

Find the number in the left column of Table III that is closest to **but more than** your Dimension A. (The next higher number.) Your Dimension B must be less than the number in the same row under Column B. For instance, if your dimension A is 98 inches, you would enter Table III at 100 inches in Column A and move right to 16½ inches in Column B. Your Dimension B would have to be less than 16½ inches.



25" From Angled or Vertical Wheel

Distance From Floor to String Inches

Minus SRP Height Inches

Difference, Must Be Less Than Inches

Dimension B in Table III

Table III on Next Page.

TABLE III*

COLUMN A	COLUMN B
INCHES	INCHES BELOW BOW
50	21½
60	20½
70	19½
80	18½
90	17½
100	16½
110	15½
120	14½
130	13½
140	12½
150	11
160	10
170	9
180	8
190	7
200	6
210	5
220	4
230	3
240	2
250	1

*Table III is based on a 27" seated eyeheight.

(5th percentile male or 50th percentile female)

And a 6° angle between the visibility line and the LWL.

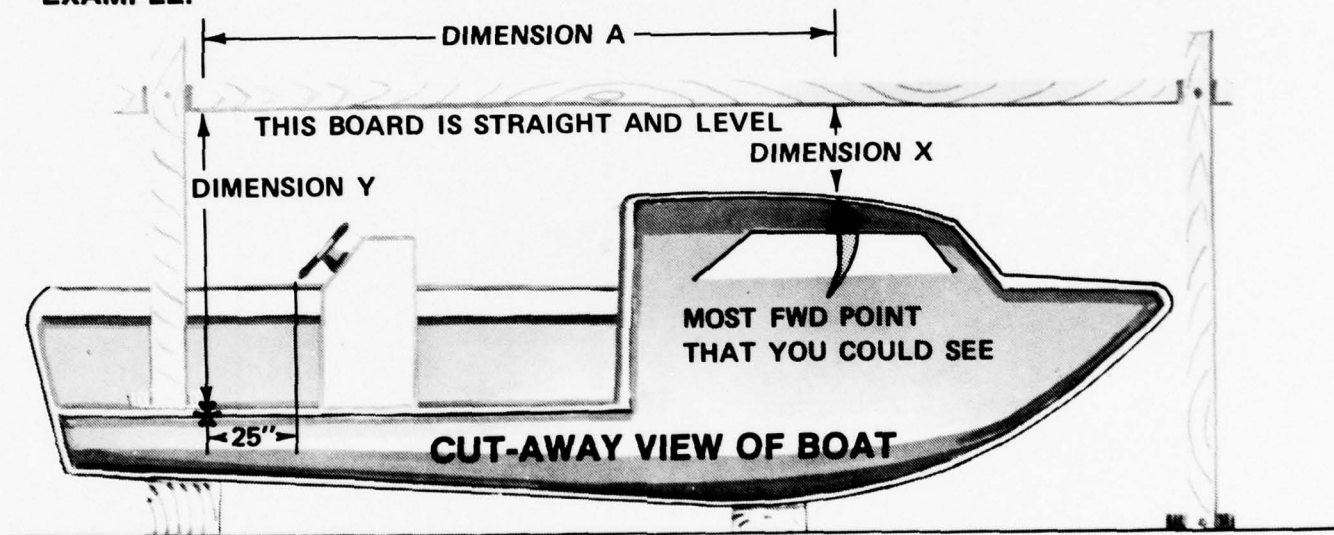
If your seated visibility doesn't meet these criteria consider using the "leaning pad" approach discussed in 5.4, moving the control station forward, or raising it, or possibly using the vertical wheel & 36" seat approach.

DO THIS IF YOU COULD NOT SEE THE BOW

Go back to Section 1.1. Go through the procedure for finding the most forward point on the boat that the operator can see, **but** use a point on the floor 25" aft of the wheel and a stick 27" longer than the SRP height of the seat that you want to use. Measure the distance between the most forward point that you could see and the point 25" aft of the aft edge of the wheel. Use that dimension as Dimension **A** in Table III. See sketch below.

Find Dimension **B** on your boat as described in Section 1.1 by subtracting Dimension **X** from Dimension **Y**. After you do that subtract the SRP height from your answer. This number should be smaller than Dimension **B** in Table III (opposite your Dimension **A**).

EXAMPLE:



Dimension Y	Inches
Subtract Dim. X	Inches
Difference	Inches
Subtract SRP Height	Inches
Difference Must Be	Inches
Less than Dim. B in Table III	

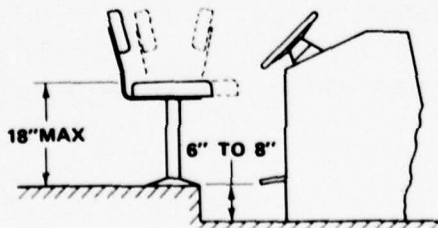
To check the seated visibility find the number in the left column of Table III that is closest to but greater than your Dimension **A** (The next highest number). Your Dimension **B** should be less than the number in the same row under the column marked Dimension **B**. For instance, if your Dimension **A** is 72 inches, you would enter Table III at 80 inches in Column A and move right to 18½ inches in Column B. The answer to your double subtraction problem, above, would have to be less than 18½ inches.

5.4 SEATING...OTHER APPROACHES

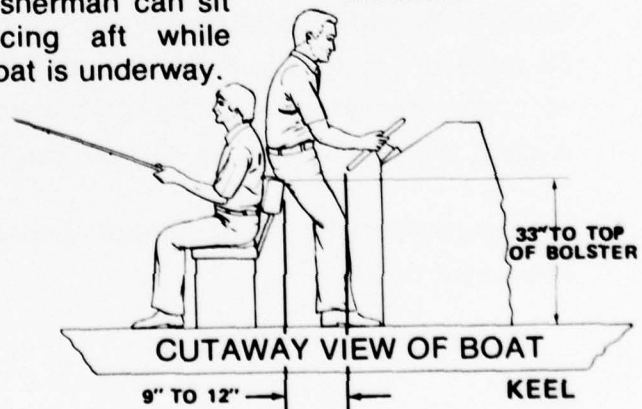
In our approach to the seating problem described in Sections 5.1 and 5.2 we considered the seat as being used only for driving purposes. But in many small fishing boats the seat is also used for fishing. If the visibility requirements have forced you into using a high seat, you may want to consider other alternatives.

1. Use the regular low fishing chair but move it aft so that when it is turned to face aft, its back is 9" to 12" from the wheel. Place a label on the control console to indicate that the seat is not designed for use while driving the boat.
2. Provide a seat that is **easily** adjustable in height. Make sure the seat height is adjustable from 18" to whatever height is necessary to meet the visibility criteria. Place a label on the control station to tell the seated operator that he should have the seat in the up position for adequate visibility.
3. Don't provide a seat for the operator. Instead provide a leaning pad that may also form the backrest for an aft facing bench seat or a rod console.
4. In some cases you can raise the deck aft of the control station. Sometimes this is the engine box or perhaps floor at the control station is actually a sunken footwell. By locating the seat on the stepped up portion of the deck, it becomes the right height for both the operator and the fisherman.

Get a very "short" seat (14" - 15") so the back won't get in the operator's way when the seat is facing aft.



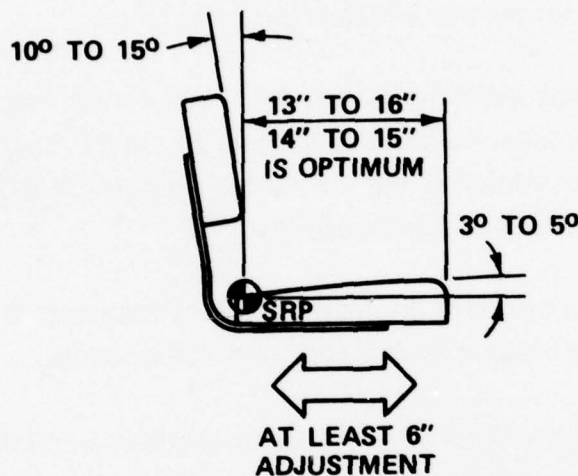
Fisherman can sit facing aft while boat is underway.



No seat for operator - operator "leans" against cushioned backrest.

5.5 SEAT DIMENSIONS

The control station was designed for the standing operator. When he sits he moves away from the control console. Reach distances become a problem. For that reason, seats designed for this application should not be as deep as normal seats and should be quite erect. This will allow the operator to sit back in the seat and still be able to reach the controls. Dimensions should look like this:



SEATING — SUMMARY

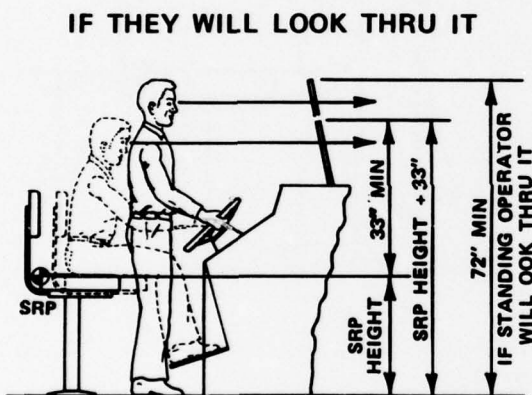
1. The height of a seat used with an angled wheel depends on wheel height as detailed in Section 5.1. Provide at least 6" of fore/aft adjustment. Leave a 9" space between the angled wheel and the seat. This is a **horizontal** measurement.
2. Adequate visibility while standing is of extreme importance. Every effort should be made to exceed the criteria. The operator's seated eye height is considerably lower than the standing operator's eye height. Because it is very easy for a seated operator to stand, the seated visibility criteria were relaxed to include "normal" running angles, but not "maximum normal" running angles.
3. If you can't meet these criteria, consider some of the "Other Approaches" discussed in 5.4.

6.0 WINDSHIELDS

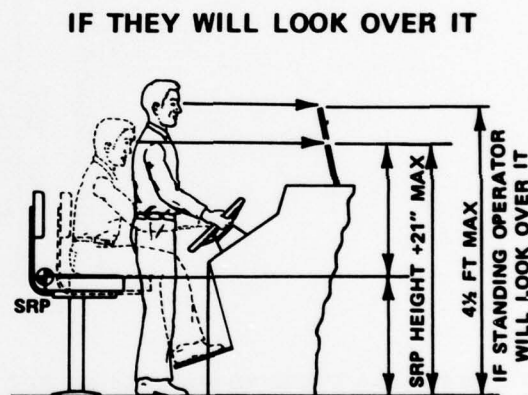
If you intend to install a windshield you should decide:

- Is the standing operator going to look over the windshield or through it.
- Is the seated operator going to look over the windshield or through it.

If the standing operator is going to look through the windshield, it should be higher than the standing eye height of the tallest (95th percentile) operator. If the standing operator is going to look over it, the top of the windshield frame or grabrail over the windshield should be no higher than 4½ feet above the deck on which the operator stands. Exception: If the windshield to operator eye distance is greater than 4 feet (measured horizontally), then he will look over it. Compute the windshield frame height as if it were the most forward point on the boat that can be seen per Table I, Section 1.0.



DO THIS IF THE
SEATED OPERATOR
WILL LOOK THRU IT

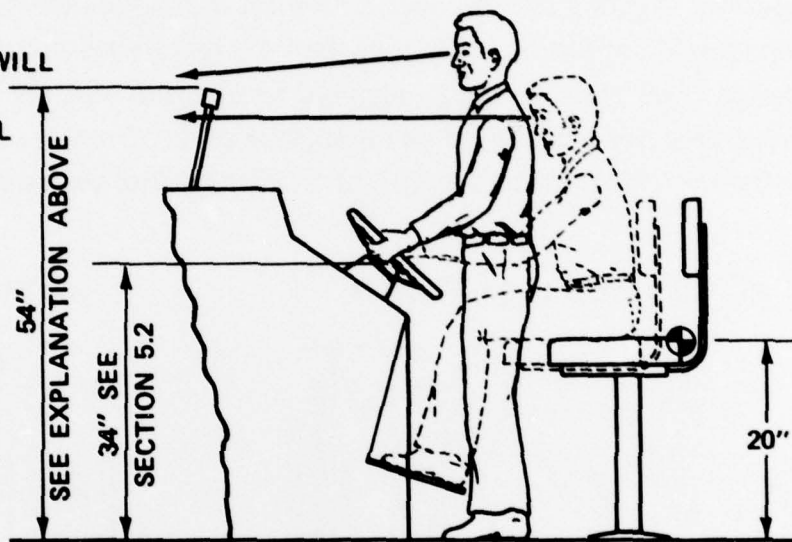


DO THIS IF THE
SEATED OPERATOR
WILL LOOK OVER IT

NOTE...If the standing operator will look over the windshield, try to place the windshield or grabrail either above or below the seated operator's eye position. To comply, the frame or rail would have to be above the sum of SRP height plus 33 inches, or if the operator will look over it, the frame or rail would have to be below a point that represents the sum of the SRP height plus 21 inches.

A logical approach is to plan the height of the windshield so that the standing operator will look over the frame and the seated operator will look under it. This approach will only work with an SRP height of 20 inches. (The minimum established in Section 5.2) Why? In order for the standing operator to look over the frame it has to be no higher than 54 inches above the deck. If the frame is 1 inch thick, the seated operator will have to look under a frame that is 53 inches above the deck. We subtract the 33 inch eye height from 53 inches and get a 20 inch SRP height.

IF STANDING OPERATOR WILL
LOOK OVER WINDSHIELD
& SEATED OPERATOR WILL
LOOK THROUGH IT.



DECORATIVE WINDSHIELDS

If you want both the standing operator and the sitting operator to look over the windshield, do this:

Add 27" to the SRP height and place a mark that distance from the end of a stick. Stand the stick up vertically so that it passes through the spot where the SRP will be (or if your seat is installed, put a mark on a stick 27" from the end and stand it on the aft edge of the seat). Sight past that mark to the most forward point on the boat that you can see. The top of the windshield should be below that line.

SIDES ON WINDSHIELDS

You may want to bend your windshield around the console to stiffen it. Make sure it doesn't extend into the area reserved for the shift/throttle mechanism. The distance between the windshield and the shift and/or throttle handle should be greater than 2". Builders of boats with small consoles **BEWARE:**

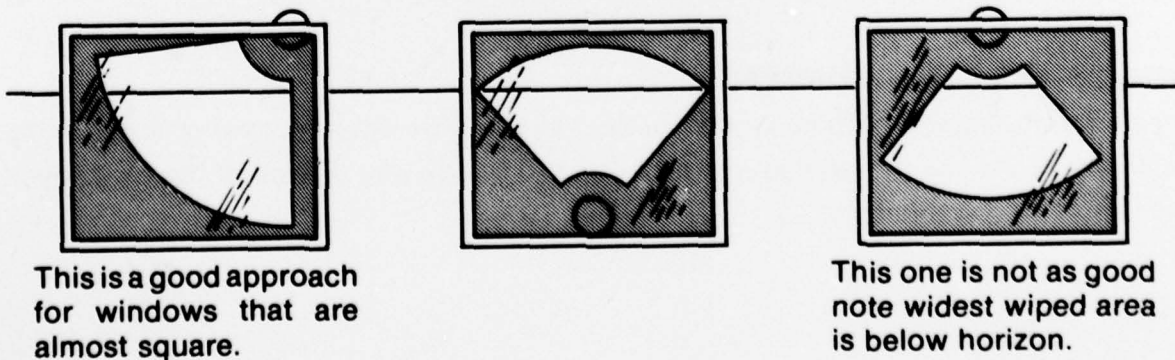


WINDSHIELD TINTING

Tinting reduces the amount of light that comes through the windshield and, therefore, reduces operator visibility. For that reason, it is not a good practice to install tinted glass in forward facing windshields. The exception is with decorative windshields where both the seated and standing operator will look over the windshield. Here, dark tinted glass may actually help to reduce glare somewhat.

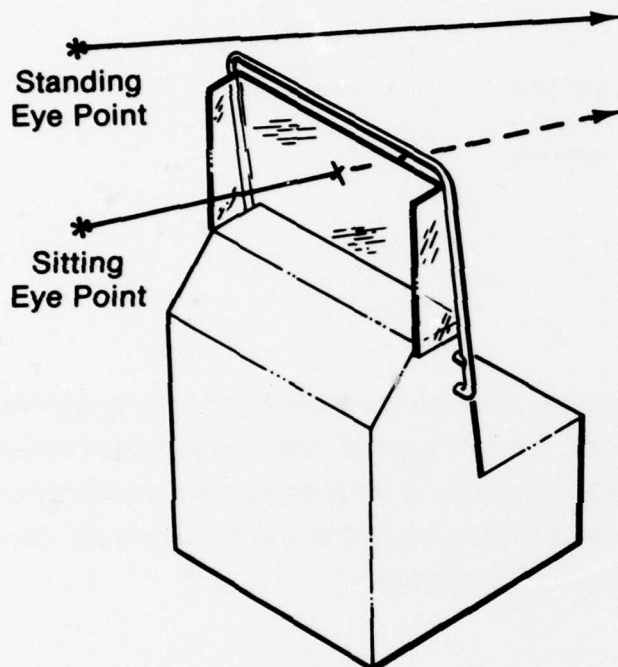
WINDSHIELD WIPERS

If both standing and sitting operators must look through the windshield you should provide a wiper. Make sure that the area of the windshield that the **standing** operator will look through is wiped the best. For instance, the horizon may appear in the top third of the windshield to most standing operators. In that case the widest wiped area should be the top third of the windshield. Suggested approaches appear below.



HANDHOLDS

Many center console fishing boats are equipped with rails which generally follow the perimeter of the windshield. If you are contemplating such an installation, make sure that the tubing going across the top of the windshield is not in the standing operator's line of sight. Follow the procedures outlined in Section 6.0. Consider the tubing as the top frame of the windshield.



NOTE...Better Yet - Don't run the tubing in front of the windshield. Then it can't obstruct the operator's forward visibility.

FRAMES & POSTS

Vertical windshield frames, posts, and other vertical obstructions forward of the SRP should be no wider than $2\frac{1}{4}$ inches as viewed from the helmsman's eye position. This means that some rectangular posts will have to be measured diagonally, depending on their location.

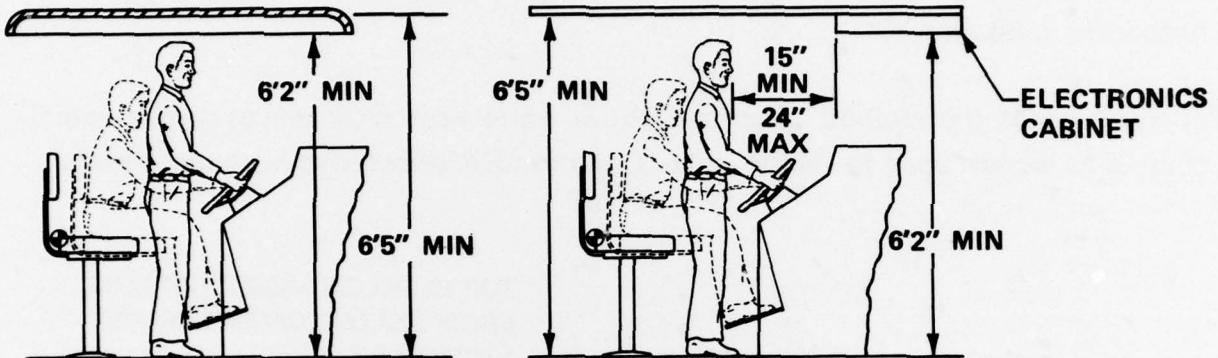
WINDSHIELDS — SUMMARY

Decide if the standing operator and/or seated operator will look over or through the windshield. Follow the procedures described to assure that the top of the windshield will be at the right height.

7.0 TOPS & CANVAS CURTAINS

Clearance between the deck and permanent or temporary tops should be at least 6'5" with lips around the edges no closer than 6'2" above the deck.

If you provide an overhead electronics cabinet, make sure that the bottom of the cabinet is at least 6'2" above the deck.



CANVAS CURTAINS

The same visibility recommendations should apply with or without side curtains. However, from a practical standpoint, some compromises must be made where the edges of each panel join. The width of the opaque reinforcing material on the vertical edges of each panel should be as narrow as possible consistent with the strength of the material. Try to maintain a maximum opaque width of 2¼ inches at the joints on panels forward of the operator. Aft curtains should have windows. The "blind spots" should be kept to a practical minimum.

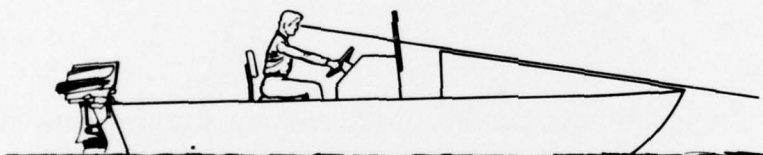
Aft curtains designed to be used while the boat is underway should have windows at a height so that both the standing and seated operator can see the horizon and water area aft of the boat. This means that the top edge of the clear portion of the side and aft curtains should be at least 6'2" above the deck at the operator's position.

DODGERS & CUDDY CABINS

Many manufacturers of center console fishing boats provide a canvas cabin forward. Unfortunately they reduce forward visibility for the standing Helmsman and obscure it completely for the seated operator. Because they are used while operating the boat they must be considered as "permanent structures." In order to meet the recommendations of this document, the visibility and therefore eyeheights should be recomputed per Section 1.1 using the top/forward point of the canvas dodger as the bow reference point. You should recompute the visibility from the sitting position as described in Section 5.3.

In many cases the method described above won't work with canvas cuddy cabins shaped as we are used to seeing them. One practical alternative is shown below.

TOP IS BELOW VISIBILITY LINE
FROM SEATED OPERATOR PER
SECTION 5.3.



TOPS — SUMMARY

The distance from the deck to the undersurface of the top should be no less than 6'5". Lips around the edges should be at least 6'2" above the deck. Dodgers should not obstruct visibility.

8.0 GLARE PRODUCING SURFACES

Glare producing surfaces forward of the helmsman can reduce forward visibility. In order to reduce the amount of glare that the operator must contend with you should:

- Specify brushed metal surfaces on rails, cleats, horns, etc., when possible.
- Try to avoid placing bright metal accessories (horns) directly in front of the operator.
- Use a tinted color for decks.
- Consider a textured surface for the foredeck on runabouts. It will reduce glare and will provide safer footing.

8.1 GLARE FROM LIGHTS

- Check to make sure that the instrument lights don't reflect into the windshield. If they do, shield them.
- Install the red and green navigation lights so they don't shine onto the deck forward of the operator.
- Try to install the white 360° light so that it doesn't reflect onto the windshield, by mounting it on a pole, or shield it so that it doesn't shine directly on boat structure forward of the operator.

APPENDIX A

JUSTIFICATIONS AND SUPPORTING MATERIAL

This portion of the Control Station Design Concepts was written to inform you of the origin of some of the dimensions and criteria contained within this document. Basically it summarizes the research effort on three basic parameters that had to be defined prior to writing the design concepts; i.e.,

- the boat operator population,
- the definition of "adequate visibility," and
- the trim angle of the boat from which to base visibility calculations.

Boat Operator Population

In order to generate eye heights, seat heights, and other dimensional criteria, the boat operator population had to be defined. We needed to know who was driving the boats at what percentage of the time. Eight hundred and seventy-nine photographs of boats underway taken at various sites around the country were reviewed and yielded a frequency count of the age and sex of those who normally operate boats. Results are presented below in terms of percentages of time that members of each group were observed operating the boats.

	Adult Males	All Females	Teenagers (M&F)	Children
Percent of Total	77	6	15	2

To design for extremes in body sizes would place an undue burden on boat manufacturers. Most vehicle design standards are based on designing for 90% of the expected user population. The biggest 5% and the smallest 5% are excluded. A body size by expected use frequency comparison was made to define just what that meant in terms of body sizes of our operator population. Results showed that we could design for approximately 90% of the boat operator population by designing for:

- the 95th percentile adult male (largest person designed for), and
- the smaller of the 5th percentile male or 50th percentile adult female.

These values were chosen because they were very close to actual values and much anthropometric data exists on those populations. Teenagers over sixteen are automatically included in the group being designed for since they tend to be taller than the lower cutoff point mentioned above.

What does this mean to you? A control station designed to meet this concept will accommodate people from 5'4" (1.6 m) to 6'2" (1.9 m) tall. For instance, minimum eye height and reach distances are based on the 5'4" (1.6 m) operator while head room and leg clearance are based on the 6'2" (1.9 m) person.

Adequate Visibility

How much forward visibility can the bow obstruct? The American Boat and Yacht Council (ABYC) currently has a standard that says that the obscured area cannot project more than 100 ft. (30.5 m) in front of the bow when the boat is at the "normal" trim angle.

Wyle researchers studied reaction times vs. speed, maneuvering distances and distances that one can distinguish a human head in the water and concluded that the current ABYC Standard is adequate with one change. The 100 ft. (30.5 m) should be measured from the operator's eye instead of from the bow.

Trim Angles

The next problem was to define "normal" trim angle. If that is "average" trim angle then the operator will not be able to see that spot 100 ft. (30.5m) in front of him for approximately one-half the time that he is boating, because his boat will be at a higher trim angle in those cases.

Instead of defining normal or average "trim angle," Wyle researchers decided that the range of trim angles should be defined and that the design criteria should be based on the highest value after some portion of the extremely high trim angles was eliminated. Running trim angles were measured from 300 photographs of boats underway. Angles were measured between the boot top or "scum" line on the hulls and the horizon. Boat operators didn't know they were being photographed so their behavior wasn't biased as a result of the study. Boats were categorized by boat type and bottom shape in an effort to reveal any differences in trim angles.

Results showed that boat type and size correlated with trim angles. When 10% of the extremes were eliminated, we found that small flat bottomed boats trimmed the highest (7° to 8°), cabin cruisers over 30 ft. trimmed the lowest (5°), and everything in between trimmed between 6° and 7° . (The purpose of the exercise was to define a minimum visibility angle for design purposes). Since eye height is proportional to boat length, we found that a system that uses a constant angle that was independent of boat type or size was feasible. The concept is shown in Figure A-1 and Table A-1. The visibility formulas contained in these concepts are based on these calculations with one exception. The visibility criteria from the seated position of center console type boats have been relaxed somewhat. The visibility criteria in these boats are based on standing eye heights. If the same visibility criteria were recommended boat builders would have two choices: raise the seat so the seated operator's eye height is even with the standing operator's eye height (a 36" (91.4 m) high seat), or lower the bow so he can see over it. Raising the seat makes it difficult to use for fishing. Lowering the bow doesn't help the sea-keeping qualities of the boat. Since it is so easy to stand from a seated position in such a boat, relaxing the seated visibility criteria seemed to be the most logical compromise.

Notice the right column in Table A-1. It says that in order for an operator of those types of boats listed to see the water 100 ft. (30.5 m) in front of him, the angle formed by the intersection of a line from his eyes to a spot on the water 100 ft. (30.5 m) in front of him and a line extending from his static load waterline will be somewhere between 9.3° and 10.4° .

In order to determine the impact on the boating industry from a concept based on this visibility angle, Wyle researchers measured the boats sampled earlier. Results are shown below:

The initial look at the data showed that at a 9° visibility angle:

- Twenty-nine percent of the boats met the concepts and appeared to be smaller than those that did not meet them. (The boats that met the recommendations averaged 16.7 ft. (5.1 m). The average length in the sample of 52 was 19.6 ft. (6.0 m).)
- In the runabout class, 33% met the recommendations. The worse case was one in which the operator's eyes would have to be raised $9\frac{1}{2}$ inches (24.1 cm).

- Only 22% of bowriders met the recommendations. The worst case was 9 inches (22.9 cm).
- Twenty percent of cabin cruisers less than 30 ft. met the recommendations. The worst case was 8 inches (20.3 cm).
- The worst case overall was from the lower control station of 60 ft. (18.3 m) cruiser. The operator's eye point would have to be raised 17 in. (43.2 cm) to meet the recommendations which would put his head at the flying bridge operator's seat level.

A 9° visibility angle would have a major impact on the boating industry. Seventy-four percent of the boats in our sample didn't meet the criteria. Because we felt that design concepts which require major changes in the basic proportions of today's boats would probably be rejected by the boating industry, the 9° criterion was relaxed to 8°. About 50% of the boats in our sample met the 8° criterion. Therefore, 8° was judged as the best compromise from both the safety aspects and the impact on the boating industry.

TABLE A-1

EYE HEIGHT ABOVE LWL	VISIBILITY ANGLE TO SEE 100 FT. (30.5 M)									VISIBILITY ANGLE = MAXIMUM ANGLE
		JOHNBOATS	SMALL OPEN BOAT	RUNABOUT	BOWRIDER	CENTER CONSOLE	CRUISER UNDER 30 FT. (10.9 M)	CRUISER OVER 30 FT. (10.9 M)	MAX. ANGLE	
3.0	1.7	X	X						8	9.7
4.0	2.3			X	X				7	9.3
5.0	2.9				X				7	9.9
6.0	3.4					X			7	10.4
8.0	4.5 (approx.)						X		5	9.5

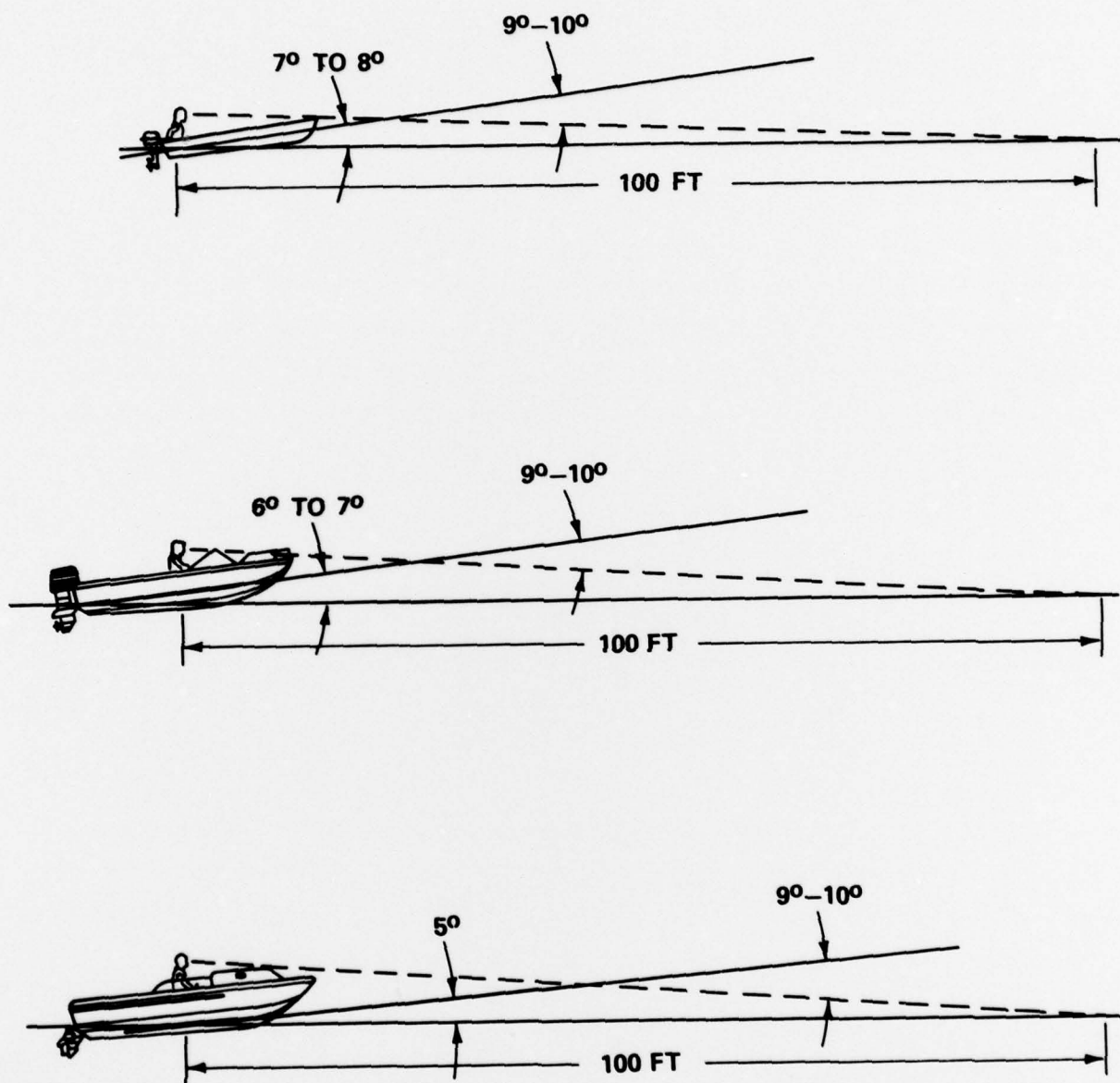
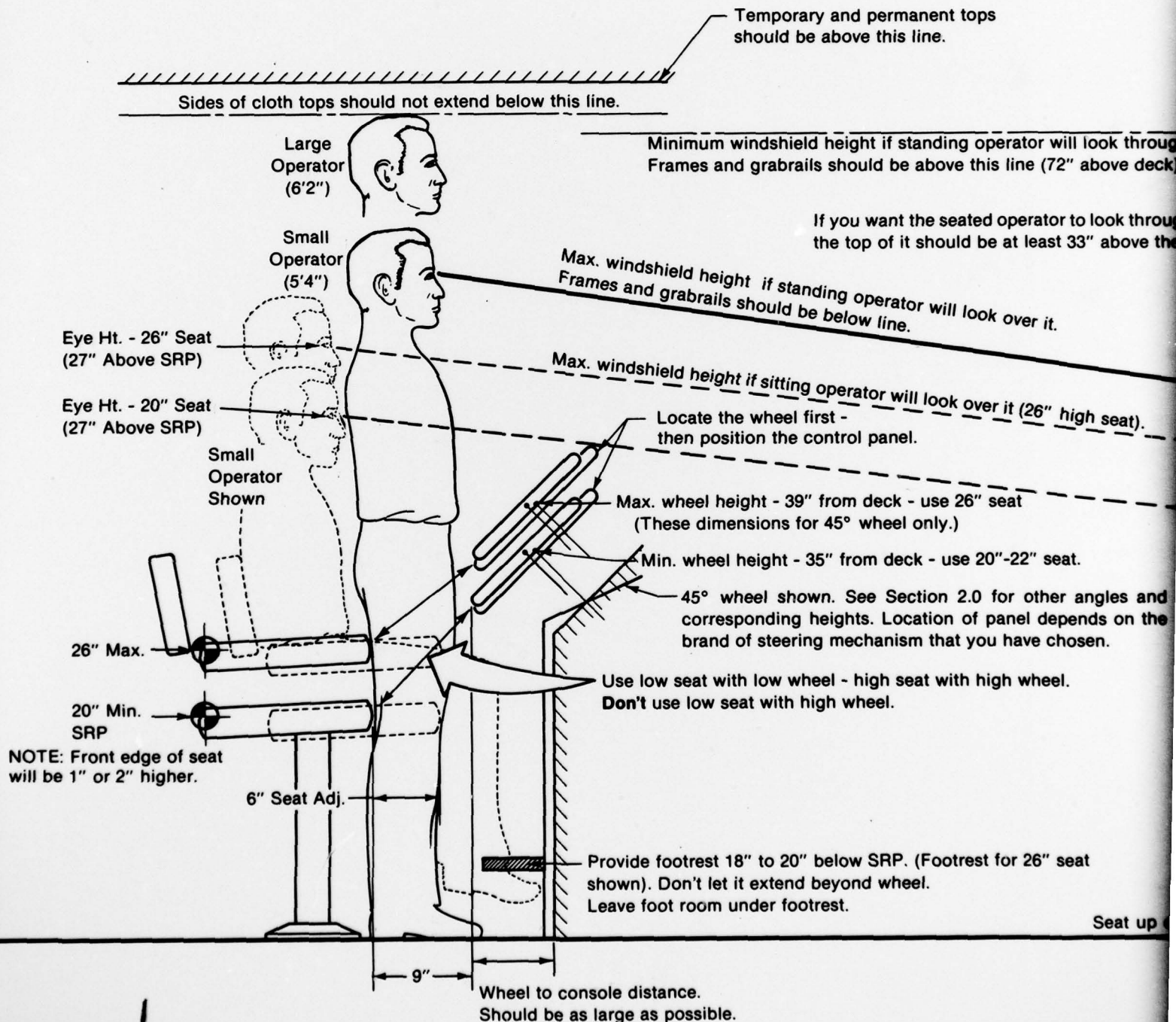


FIGURE A-1

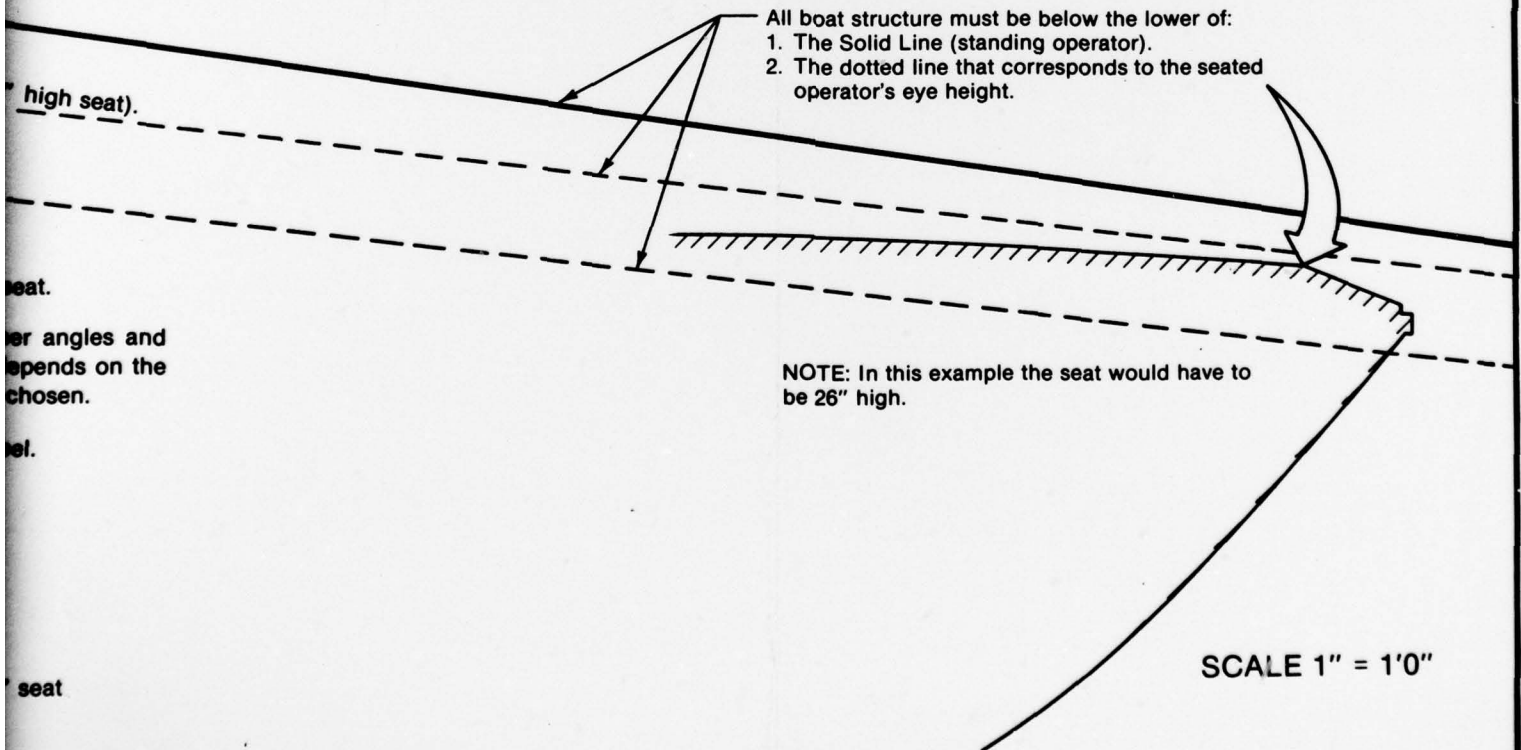


PART 2

CONTROL STATION DESIGN CONCEPTS FOR BOATS WITH A "CENTER CONSOLE" FOR DECK BOATS, PONTON BOATS, AND ALL CONTROL STATIONS DESIGNED FOR STANDUP/SITDOWN OPERATION EXCEPT CONTROL STATIONS ON CABIN CRUISERS

SUGGESTED USAGE

1. Position this sheet under your profile drawing so that the base line of this drawing is parallel to the load waterline of your boat.
2. Adjust this drawing so that the baseline under the operator's feet coincides with your boats' deck height and projected operator placement.
3. Check the line extending from the standing operator's eyes. It should be above all boat structure.
4. Check to assure your wheel is within the limits shown. If your wheel is at a different angle, check Part 1 of the Guideline for dimensions.
5. Adjust this drawing so that one of the seats shown coincides with your seat height. Make sure all boat structure is below the appropriate dotted visibility line.
6. Check this concept for shift/throttle location, instrument locations, etc.



Seat up drawing so that this line is parallel to your designed load waterline.